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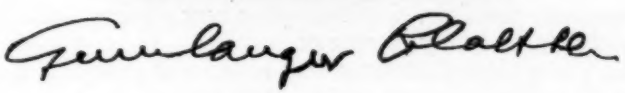

In Memoriam

GUNNLAUGUR CLAESSEN, Iceland's first radiologist and one of the most interesting and many-sided personalities within radiology, died on July 23rd, 1948 from acute pneumonia following a severe attack of asthma.

CLAESSEN was born on December 3rd, 1881 in Sauðárkrókur in northern Iceland. His parents were JEAN VALGARD VAN DEURS CLAESSEN, a merchant from a Danish and Dutch family, and KRISTÍN BRIEM, a daughter of EGGERT BRIEM, sheriff in Skagafjörður county in Iceland, whose ancestors can be traced more than a thousand years back.

After having matriculated in Reykjavik in 1901 CLAESSEN studied medicine at the University of Copenhagen from which he graduated in 1910. He received his radiological education in Copenhagen, at Professor J. F. Fischer's Roentgen Clinic and Rigshospitalet, and in Stockholm at the Roentgen Department of the Serafimerlazarett and Radiumhemmet. Later, in 1928, he took his medical degree at Karolinska Institutet in Stockholm. Numerous study tours to England, Germany, France and Sweden contributed to deepening his radiological education and enabled him to keep pace with the advances made.

From 1913 he worked for a few years as a general practitioner in Reykjavik. From January 1st, 1914 he was appointed head of the new »University Roentgen Institute» in Reykjavik.

In 1914 CLAESSEN married THORDÍS BJÖRNSDÓTTIR of an old Icelandic family, and they had two daughters, ANNA born in 1915 and THORDÍS born in 1919, both of whom are now married in Denmark.

In 1930 CLAESSEN was appointed Chief of the Radiological Department of the newly established University Hospital in Reykjavik, and from that year he lectured on radiology at the University of Iceland.

When CLAESSEN set up in practice in Reykjavik, Icelandic medicine had no access to the new rays. CLAESSEN embodied the expert knowledge, the enthusiasm and the organizing ability required to build up a radiological institution from the very start. At the request of the Medical Faculty of the University of Iceland, the necessary means were procured in 1913, and under CLAESSEN's leadership »The University Roentgen Institute» was established in 1914 in three small rooms with a roentgen unit from Siemens & Halske, for roentgenography, fluoroscopy as well as minor roentgen treatment. On April 3rd, 1914, the first patient was roentgen examined. In January 1919 the Roentgen Institute was moved to new spacious premises, obtained quite new equipment from Koch & Sterzel and was gradually completed.

At the same time CLAESSEN was able to supplement his roentgen therapy with *radium therapy*, and in 1922 he could add a well equipped department for universal and local *light therapy*.

In this way CLAESSEN in out-of-the-way Iceland built up a radiological institution fully on a level with the development in radiology, both as regards the quality of the work and many-sidedness, and which all the time has utilized every progress within radiology.

Among CLAESSEN's publications in *the field of roentgen diagnosis* there are a few in Icelandic, partly of a general instructive nature, partly dealing with the development of the Roentgen Institute of the University of Iceland.

The majority of his diagnostic papers have, however, been published

in international literature, and several of them add valuable contributions to the development of roentgen diagnosis.

As early as 1923 he reported three cases of *roentgenologic »niche» symptoms in cancer of the stomach*, pointing out the chief features in the differential diagnosis and emphasizing the importance of an accurate roentgen control in chronic gastric ulcer.

He has given an excellent description of the roentgen appearances in *syringomyelitic arthropathy*.

Even before screen photography had come into use he recommended *the use of roentgen paper for lung diagnosis in prophylactic mass examinations for tuberculosis* and stressed that many things indicated that »the serial mass examinations mark the opening of a new splendid era of social hygiene in the fight against tuberculosis».

In a series of papers CLAESSEN gave the most thorough and complete description yet published on *roentgen diagnosis in hydatid disease*. Below will be pointed out only a few observations of general interest to the diagnostician.

The geographical spread of the echinococcus disease is wider than generally supposed. Being rather common in the »classical echinococcus countries», it is endemic in many localites, and occurs sporadically everywhere. Echinococcus cysts may be found in any of the organs, but the parasite lodges by preference in the *liver*, where about seventy-five per cent. of the cysts are found. The deposition of calcium salts in the degenerated fibrous capsule of the cysts is of great importance as regards the roentgen examination, the calcareous shadows oftenest appearing as smaller or larger portions of a shell or as annular tracings.

In Iceland, *primary pulmonary echinococcus cysts* are extremely rare. All the cases sent to the Reykjavik Clinic diagnosed as echinococci of the lung proved, when correctly roentgen examined, to be sub-phrenic liver cysts that had ruptured into the bronchi. CLAESSEN's experience suggests that also in other countries the echinococcus cysts may not be of primary pulmonary origin as often as supposed. The sub-phrenic liver cysts in many cases simulate primary cysts in the base of the right lung as the result of faulty or incomplete roentgen technique.

Echinococcosis in bones constitutes from one to two per cent. of all cases of the disease, mostly located in the pelvis, but parasitic cysts have been observed in practically all parts of the skeletal system. The roentgen symptoms vary considerably. The destructions in some cases may resemble any kind of malignant tumour, while, in other cases, they are of a more benign character. An important pointer for the roentgen diagnosis is the absence of any regional atrophy of the bone and of any reaction on the part of the periosteum.

The work which contributed most to making CLAESSEN's name known

among medical men in Scandinavia outside the circle of radiologists is his »Diagnostic Radiology for Practitioners and Students», issued in two editions in Danish (1940 and 1946). This book occupies an exceptional position among text-books of roentgen diagnosis because of the clearness and ease with which the reliable and skilful teacher step by step guides the pupil, who is entirely inexperienced within this subject, into the edifice of roentgen diagnosis.

In order to make the material more comprehensible to the beginner the author has to a great extent linked the descriptions of the roentgenograms with the pictures preserved in memory from the anatomic instruction and with the clinical findings. In connection with these comparisons he describes the working methods of roentgen examination and the interpretation of the roentgenograms. Step by step the beginner is made familiar with the principles which apply when it is a question of re-constructing the anatomical picture from the roentgenograms, *i. e.* of making the roentgen diagnosis. Well selected illustrations bear witness of the high technical standard at the Radiological Department of the University Hospital in Reykjavik.

CLAESSEN's text-book is in general use and in high esteem at the Scandinavian universities. An English edition is now in press.

CLAESSEN's numerous publications dealing with the subject of *irradiation therapy*, the majority in Icelandic, embrace *radium*, *roentgen* and *light therapy*, extending to most fields within irradiation therapy. They are partly papers of didactic nature, partly reports of the results obtained by irradiation therapy at the Therapeutic Clinic of the Radiological Department of the University Hospital in Reykjavik. Apart from revealing the author's learning, thoroughness and excellent judgment, these works go to show the high standard of irradiation therapy in Reykjavik.

Particular interest attaches to CLAESSEN's achievements in the *roentgen therapy of favus*, summarized in English in Acta Radiologica, 1937, which deserve to be studied by everyone who has to do with this disease. Through a method of treatment which he developed to a high degree of efficacy, an untiring follow-up, and unselfish care for the patients, he obtained a result in the treatment of favus which must be called unique. All 152 cases treated during the period 1915—1935 — practically all the cases which could be traced in Iceland — were cured without alopecias worth mentioning and without recurrence in more than 4 cases, 3 of whom yielded to renewed treatment.

During the years 1940—1948 CLAESSEN was an interested member of the Editorial Staff of the Acta Radiologica.

To be able to estimate the true value of GUNNLAUGUR CLAESSEN's achievements as a physician and scientist, one must realize that nearly all his works within radiology were links in major medical campaigns.

His many-sided knowledge and great organizing capacity came into their own in leading positions in the service of practical medicine and society. Thus, he was one of the founders of the »Icelandic Red Cross» and its president for years. For a long time he was president of the Icelandic Medical Association and from 1923—30 editor of the Journal of the Icelandic Medical Association. During the period 1920—26 he was an active member of the Town Council of Reykjavik.

CLAESSEN has inscribed his name in Icelandic medical history by his successful campaign against two diseases which were endemic in Iceland, *hydatid disease* and *favus*.

As a member of the Town Council he carried a law prohibiting the keeping of dogs in the town which made the eradication of hydatid disease in Reykjavik possible and gave him the nickname »Dog Herod».

By means of energetic propaganda and education through the daily papers, by excellent organization for tracing the patients with favus, admirable treatment and energetic follow-up, he also succeded in liberating his country from favus as an endemic disease. Now there are years between the occurrence of new cases.

Moreover, CLAESSEN was an active participant in the organization of Iceland's campaign against tuberculosis and cancer. It was he who organized and led the national collection from 1917—18 which made it possible to purchase radium for the Radiological Institute in Reykjavik.

From 1914—20 and again from 1923—26 CLAESSEN lectured on physiology at the University in Reykjavik.

From 1941 until his death he was Editor of »Heilbrigt líf» (»Healthy Life»), a periodical dealing with medical subjects in popular form, published by the Icelandic Red Cross, and he wrote a large part of the contents himself.

CLAESSEN devoted great interest to the introduction of *cremation* in Iceland and in 1934 he founded the Icelandic Cremation Society of which he was president until his death. This Society has now established a crematorium in Reykjavik, and by a strange play of destiny his body was the first to be cremated there.

CLAESSEN also utilized his knowledge of physiology and hygiene for the benefit of his people in a number of publications, particularly within the fields of alimentation and vitamin research and general hygiene.

In connection with his activity within practical medicine and social medicine, he has published articles on the prophylaxis of tuberculosis, hydatid disease, and favus. His reports on the spread and occurrence of favus, in particular, abound in valuable observations and fresh suggestions.

He was a master in the difficult art of popularization. His ardent interest in popular education, his many-sided medical knowledge and

deep-rooted culture are reflected in a large number of articles in Icelandic periodicals and newspapers on problems relating to general and social medicine and hygiene.

CLAESSEN was richly endowed with stylistic gifts, both in writing and speaking. He had inherited his Icelandic ancestor's capacity for collecting much wisdom and experience in brief sentences, and often a glimpse of quiet humour would light up his serious statements. His linguistic talents were astounding and he expressed himself with exceptional ease in foreign languages. In addition to his native tongue, Icelandic, he spoke and wrote Danish, Swedish, English, German and French fluently.

From 1941 CLAESSEN suffered from asthma manifesting itself in violent attacks. During his periods of illness, which did not infrequently last for months and during which he was unable to work in his Clinic, he utilized his linguistic talents to translate into Icelandic several foreign books dealing with popular medicine or educational matters.

With the assistance of Dr. MCLAREN of London who at that time served with the British Forces stationed in Iceland, CLAESSEN also prepared the English edition of his text-book »Diagnostic Radiology for Practitioners and Students», which he finished and supplemented with the most recent advances within radiology before he died.

In order to stand out in true relief GUNNLAUGUR CLAESSEN's figure must be considered in the light of the struggle for progress fought by the Icelandic people to which he gave his life's work. He was to perform his work at a time while his native island was in seething motion to raise itself from a period of stagnancy and gain economic and political independence.

It fell to CLAESSEN's lot primarily to build up the edifice of radiology in Iceland from the very ground, and this he accomplished in a way which made his radiological institution a pillar of modern Icelandic medicine and himself a teacher setting an example to all Scandinavian radiologists. But he also took part in building several other sections of modern medicine in Iceland with great enthusiasm and great success.

In many respects he was an educator of his people. The story of his life and pioneer work cannot but remind us of a narrative taken out of the Icelandic sagas.

GUNNLAUGUR CLAESSEN was an important and charming man. His virile and warm mind gained our friendship, his work our admiration.

Gösta Forssell.

My thanks are due to Dr. G. FR. PETERSEN of the University Hospital, Reykjavik for information regarding GUNNLAUGUR CLAESSEN's Icelandic publications and to Mrs. ANNA LA COUR, née Claessen, for supplying biographical facts about her father and for assisting me in the translation of this memoir.

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[1] *Abbreviations.*
Icel. = published in Icelandic. *Rvk.* = Reykjavik.
Alm. ísl. þvf. = Almanak h. ísl. þjóðvinafélags = Almanac of the Icel. Soc. of the People's Friends.
Eimr. = Eimreiðin = The Locomotive = A Quarterly supplying articles of instructive nature.
Hlín = name of Goddess in Scandin. mythology; Annual Rev. issued by the Women's Soc., in Northern Iceland.
Lbl. = Læknablaðið; The Journal of the Icel. Med. Association.
Ljm. = Ljósmæðrablaðið; The Midwives' Journal.
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THE PERCEPTIBILITY OF DETAILS IN ROENTGEN EXAMINATIONS OF THE LUNG[1]

by

G. C. E. Burger

I. Introduction

The roentgen image is produced by a complicated process, in which the absorption and scattering of the roentgen rays by the object, the formation of the image on screen, photographic emulsion and retina and the apperception play a part. In fluoroscopy one of these factors (the photographic plate) is missing. The roentgen image shows variations in contrast and sharpness and these are the limiting factors that determine the perceptibility of details. In the method of mass chest-radiography another series of factors is added, originating from the qualities of the optical system used. The limits of perceptibility are furthermore dependent on the brightness and colour of the image on the retina. The low brightness of the image in fluoroscopy ($\pm$ 0.01—0.001 milli-Lambert) is the cause of the less favourable results of this method as compared with the photographic picture. This is true, notwithstanding the fact that the eye shows an extremely high adaptability to different intensities of light (factor 10^{10}) and the colour of the screen coincides with the optimum of the curve representing the relation between wave length and minimum energy to produce a visual effect in the retina, which stands for a gain of a factor 2.

It is of great importance to possess exact information concerning the limits of perceptibility in different roentgen methods. Just as in using a microscope, we should know the *resolving power* of every roentgen-method under the special conditions in which it is used. This resolving power is defined by the smallest object, that can be distinguished. Because the roentgen examination of the lungs makes as a rule the highest demands in this respect, the methods needed in order to estimate the resolving power have to start from the special conditions of the lung image. Up till now the quality of different roentgen pictures and methods

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has as a rule been estimated only in a qualitative and very subjective way. This is no doubt the reason for the divergence in opinion about the merits of special roentgen techniques. This *subjective* judgement should be replaced by *objective* measuring. Now that the mass-survey methods will be used on a large scale for the detection of wide-spread diseases (tuberculosis, miners' pneumoconiosis) the necessity for such an *objective* examination is evident.

The principle of these methods is based on the examination of a *phantom*, with qualities that make a comparison with lung conditions possible. A well constructed lung-phantom will be an adequate instrument for measuring the resolving power that we want to know.

A brief survey of some observations already published may precede the descriptions of some newer methods which have recently been developed. BRONKHORST (1) made a careful and detailed study of contrast and sharpness of the roentgen image and of the conditions that influenced these determining factors for the perceptibility of details in radiography, using a phantom made of aluminium sheet (12 steps from $^1/_2$ to 12 mm Al) and water. The smallest difference of film-density that was easily perceptible was shown to be $\pm$ 0.025 in these experiments.

From the experiments a large number of contrast curves were derived determining the contrast qualities of pictures taken under different conditions. The physical basis of the factors influencing the sharpness of the image was also established experimentally. Subjective evaluation was replaced by physical measuring and in this way experiments contributed largely towards placing radiography on an exact basis.

LUFT (2) experimented with a phantom of gelatin and measured the perceptibility of detail from the smallest layer of this material that could be observed in roentgen pictures made with tensions between 38 and 115 K. V. In the range of the tensions normally used in lung diagnostics, values were found between 0.7 and 1.3 mm gelatin.

The mutual dependence of contrast and size of the detail as a determining factor for the perceptibility, however, was not considered in these experiments; the phantoms used were not suitable for this purpose.

Special experiments in this direction were made in connection with the question concerning the value of fluoroscopy as a method of case-finding in tuberculosis control (E. DE FINE LICHT (3), H. CHRISTENSEN (4), G. C. E. BURGER and B. VAN DIJK (5) and E. v. ROSEN (6)).

G. C. HENNY and W. E. CHAMBERLAIN (7) added new facts and compiled a very instructive review in a study called: »Roentgenography, fluoroscopy».

A brief summary of some facts taken mainly from our own experiments may follow here. The phantom used was built up of pertinax or

bakelite plates and the objects to be perceived consisted of small objects of the same material fixed on a bakelite plate (»positive» phantom) or of holes drilled in such a plate (»negative» phantom). It was shown that these two methods gave corresponding results in estimating the limits of perceptibility.

Regarding the selection of the material it is essential to make use of a well defined chemical compound with an average atomic number of the same order as the organic compounds contained in the thoracic wall and in an infiltrative inflammation of the lungs. The substance used must have physical properties of absorbing and scattering roentgen rays, in the same way as a thorax. Only when this is the case may we draw direct conclusions concerning visibility under different conditions, especially with changes in the kilovoltage used. Bakelite mainly composed of a condensation product of formaldehyde and cresol (spec. weight 1.33) proved to be satisfactory in this respect and it is a material relatively easy to handle for the construction of a phantom. The following figures give a comparison of the material used in our phantoms as compared with water:

	Water	Bakelite
Density	1.0	1.3
$\frac{\text{Transmission 100 KV}}{\text{Transmission 50 KV}}$	1.33	1.34
(measured in a layer of 36 mm)		
Mass-absorption coefficient Θ/ϱ	$2.6\,\lambda^3$	$2.3\,\lambda^3$
Mass-dispersion coefficient σ/ϱ	0.19 cm^2/gr	0.18 cm^2/gr

(absorption coefficient $= \Theta$, density $= \varrho$ and dispersion-coefficient $= \sigma$).

As pointed out before a definite connection exists between contrast and size of the smallest visible detail. This connection which can be called *perception curve* or *contrast-size diagram* (c. s. d.) (fig. 1), is characterized by the following two principles:

(1) For details with a *great contrast* the limit of perceptibility is determined by the visual acuity of the eye.
(2) For details with a *small contrast* the limit of perceptibility is determined by the sensitivity of the retina for contrast.

We will not discuss here the question, whether these two qualities depend on the same or on two different properties of the retina.

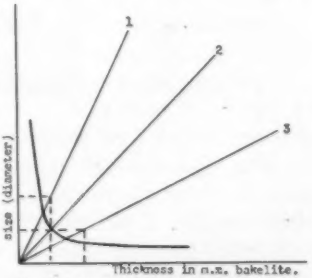


Fig. 1. Contrast-size-diagram (c.s.d.) or perception-curve.

The examinations with the phantoms used in our former experiments were rather laborious and therefore we tried to simplify our method, estimating the curve by determining the limit of visibility on three lines representing objects in which diameter (size) and depth (contrast) were related as 2 : 1 (line 1), 1 : 1 (line 2) and 1 : 2 (line 3) (Fig. 1). We were able to show that the size of the smallest visible cube (edge) had a ratio of 1 : 1.2 to the smallest visible ball (diameter). Later experiments made it clear that the ratio cube to cylinder (diam. = depth) is somewhere about 1 : 1.1.

The use of a »negative» phantom with cylindrical holes has the great advantage that such a phantom can easily be manufactured by drilling holes in a bakelite plate of the desired thickness.

With these methods we could show, for example, the following facts:

(1) In fluoroscopy with the usual technique (4 mA 55 K. V.) the smallest perceptible contrast is $\pm$ 8 %, which means a thickness of 3—4 mm bakelite in a normal average lung field.
(2) Increase of the brightness of the fluoroscopic screen, caused by the use of a higher tension (KV), a stronger current (mA), or a better screen, gives an improvement of perceptibility of detail. Diminution in brightness of the retina image caused by narrowing of the pupil has the opposite effect.
(3) Improvement of sharpness (smaller focus, better screen) has a measurable influence on the perceptibility of detail, *e. g.* a focus of 1.4 mm as compared with one of 3.8 mm gives an improvement of some 20 %.
(4) Movement of the object, as is usual in fluoroscopy has the effect that 10—15 % smaller objects can be observed.
(5) The smallest visible cylinder in screening (Levy West screen, 1.4 mm focus, 4 mA and 55 KV) is of the order of 3.0 to 4.5 mm (for a thickness of the thorax, corresponding to 72 or 92 mm bakelite or $\pm$ 18 to 24 cm sagittal thorax-diameter).

For further details the original articles may be consulted.

These experiments had shown that the principles of the method were sound. BURGER (8) and AXÉN (9) measured the perceptibility in *mass chest radiography* with these methods and showed that the results of the miniature picture were better than those of fluoroscopy, but remained definitely behind the normal-size contact picture.

The time necessary to come to a definite result in these estimations was too long to make them generally applicable for the examination of larger series. When we consider, however, the many factors that are of influence on the quality of a miniature picture (filmtype, time and method of development, optical conditions of the camera, grid, screen, mAs, tension, tube focus etc.) it is obvious that methods are needed that

guarantee the possibility of a rather quick investigation of these conditions.

Apart from this there is still another problem calling for a definite answer. When for example we have to compare two different methods used for the purpose of mass chest pictures and we determine a certain difference in perceptibility of detail, what will be the influence of this difference in practice? How does this difference affect the exactness of diagnosis, the recognition of details, the time of observation needed for apperception of the total image?

In the following parts two new methods are described which answer at least for a greater part the demands mentioned above.

II. (1.) The Contrast-Size Diagram (c. s. d.)

With this method an attempt has been made to provide an instrument for estimating directly and in a short time the total curve representing the borderline between the visible and invisible details, for a wide range of objects of different size and contrast.

The design of the phantom is indicated in fig. 2 and 3.

With this simple apparatus it is very easy to change the thickness of the »thorax» by placing more bakelite plates in the phantom. Also the place of the object plate can be easily varied, this being put near the screen, between the bakelite plates or at the

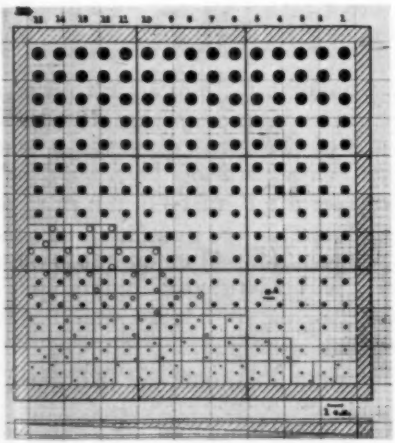


Fig. 2. Object-plate for contrast size diagram. A: point of centration.

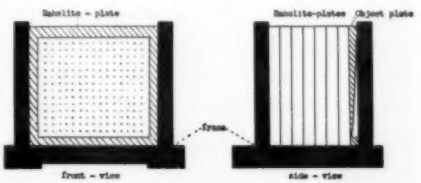


Fig. 3. Construction-scheme of bakelite-phantom.

»back» of the phantom. For the case that the exposure time is a factor that must be taken into consideration, a satisfactory result can be obtained when the object plate is placed in a frame that can be moved with a certain velocity. For this purpose a construction is added which

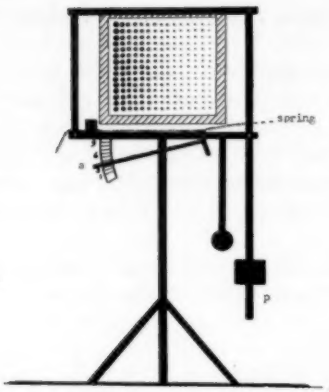


Fig. 4. Device for the examination of motion-unsharpness.

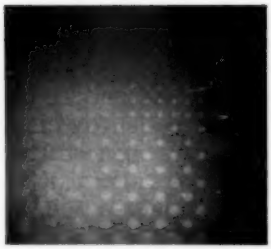


Fig. 5. Roentgen picture (mass-chest 45 mm) of object-plate (contrast increasing from left to right).

is shown in some detail in fig. 4. The velocity of the object can be approximately determined beforehand by changing the angle of the pendulum p. at a. A small lead mark, attached to the phantom, is photographed during exposure and permits the exact measuring of the unsharpness and the time of exposure.

The object plate (fig. 2) consists of a bakelite plate of 1 cm thickness in which cylindrical holes are drilled in such a way that the holes (marked ●) in every *horizontal* row are of the same diameter but of varying depth (contrast) and in every *vertical* row of the same depth and varying diameter. Depth and diameter are from 1—8 mm in steps of 0.5 mm.[1]

When looking at a picture of this phantom (fig. 5) or an image on a fluorescent screen three different zones can be observed:

(a) a zone in which we can see all details
(b) a zone in which we cannot distinguish anything
(c) a »borderline» zone in which we see some indistinct inhomogeneity.

From physiological considerations it is quite obvious that we cannot expect a very clear and sharp borderline between the visible and invisible parts. This fact, however, gives some uncertainty in the estimation of the c. s. d. Reliability of results can be considerably increased, however, when the holes marked ○ (fig. 3) are added. These holes have exactly the same size as the hole in the center of the quadrangle. When there is any doubt whether the observer can see a certain hole, he has to mention the place where the »duplet» is situated. In order not to disturb the

[1] In a number of cases we have added a row of cylinders with a depth of 0.5 mm.

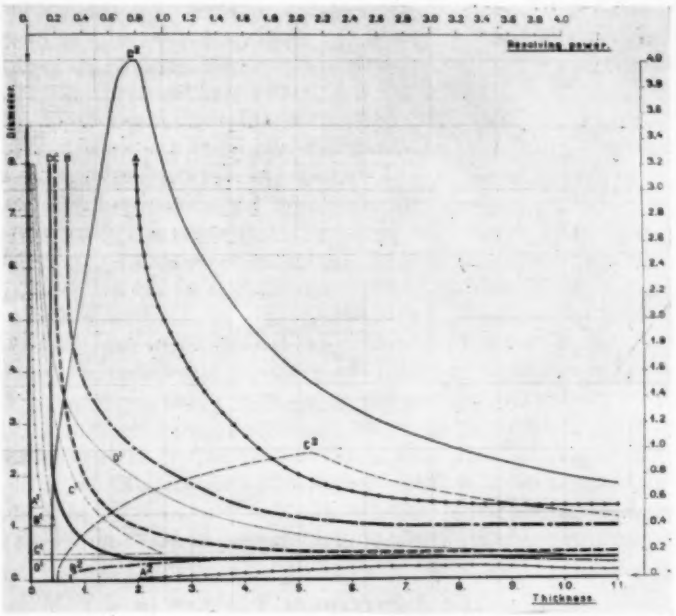


Fig. 6. Four contrast-size diagrams A (fluoroscopy) B and C (mass-chest pictures) and D (contact picture) and the curves of resolving power belonging to them, plotted against thickness (horizontal axis), scale at upper end of picture 0.2, 0.4 etc. — 4) and diameter (vertical axis, scale at right side of picture).

number of holes in the horizontal and vertical rows, four different places for these »duplets» are chosen. For one single case the chance of guessing the right place is 25 %; when, however, this procedure is repeated in other parts of the curve it is possible to estimate the correct situation of the borderline. The observer, placed in a distance of optimal vision, starts with row 1 at the right upperside and counts, going horizontally to the left, the number of holes he can detect; he continues with row 2, etc. and coming in the important zone of doubt he can make sure if a certain hole is seen by mentioning the situation of the duplet. The data are plotted in a diagram and give a direct result.[1]

[1] For really optimal results it would be necessary to drill the holes in the plate not perpendicularly to the surface but in a direction centered to a point at the same distance as the focus to plate distance of the apparatus. This condition would require, however, a number of different object plates for several focus distances. It was found that the error is not of importance when, in taking a picture, the central ray is directed towards a point marked A in the scheme of fig. 3.

The *resolving power* of a roentgen method can be defined as the reciprocal value of the content of the smallest visible object measured as a cylinder. Thus a resolving power of 0.5 means that a cylinder is visible with a content of 2 mm³. In fig. 6 four perception curves are reproduced corresponding with fluoroscopy (A), two different methods of mass-chest photography (B and C) and a normal-size contrast-picture. From these perception curves the reciprocal contents of the smallest visible cylinders (*e. g.* the resolving power) are calculated for several points of every perception curve and the results plotted in the same diagram as a function of diameter (upper scale) and of thickness or contrast (right-side scale). These curves represent an objective evaluation of the resolving power of any method of roentgen examination.

The shape of the curves indicates, that a thin, and relatively long cylinder, seen on top, represents the smallest amount of material that is visible. For practical purposes the most interesting object, however, is a cylinder with a diameter equal to the depth, because this is not much different from a little ball, which, as we may expect is approximately the anatomical substrate of a fresh nodulus in the lung. In the contrast-size diagram this »equal-sized» cylinder can be found at the crossing of the perception curve and the line 2 (fig. 1) drawn in an angle of 45°.

II. (2.) The Apperception Diagram (a. d.)

This method is based on the observation that the time needed for reading the holes in order to estimate the perception curve of the c. s. d. is very clearly influenced by the quality of the picture. The better method not only gives a better curve, but the estimation of the curve demands much less time and is carried out with fewer errors. Since the apperception of small and vague shadows in a roentgen picture also requires a certain amount of time, it seemed evident that the determination of the time needed for observation and the errors made could be a fair measure for the quality of the roentgen method under consideration.

For this purpose another object plate was made in which groups of holes are drilled in numbers from 2 to 6 in 20 different quadrangles separated by small contrasting lines. In our experiments described in part III two sets of holes were used consisting of 20 rectangles each, containing holes of 2 mm depth and with a diameter of 5 mm in one set and 5 mm depth and 2 mm diameter in the other set. The results with this method were satisfactory but in the next set of object plates we added a third set of holes with a depth of $3^1/_2$ mm and a diameter of $3^1/_2$ mm (Fig. 7).

The size of the holes is such that they represent borderline cases in a picture taken with a mass chest apparatus. In fluoroscopy they may be a little too difficult for less favourable circumstances or for observers with a not ideal vision.

The experiment is carried out as follows: The observer is placed at an optimal distance in front of the screen or the projection screen, or he looks into a viewer; the object is made visible and the observer has to count the number of holes in every square. He is asked to do this as exactly and quickly as he can. The time taken to read a set of 20 squares is noted. When the exact number of holes in a square is not given this is noted as one mistake. In this way it proved to be very easy to measure the difference in quality of different roentgen methods.

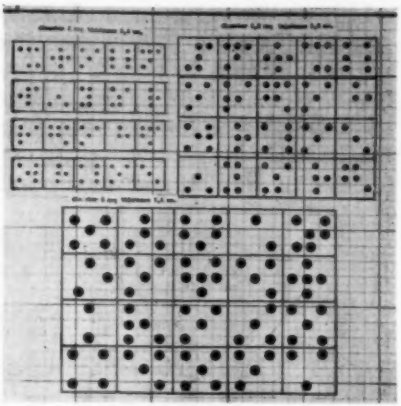


Fig. 7. Object-plate for Apperception-diagram.

The figures of time and mistakes can be noted in a table or plotted in an apperception diagram (a. d.) (Fig. 14—19) in which the ordinate stands for the number of mistakes and the abcissa for the time in seconds. For some of the observations it would be possible, following a statistical method, to express for example mistakes in seconds: working at a slow speed will result in fewer mistakes than reading at a high speed. This method cannot give quite satisfactory results, when we have to read real borderline cases in which mistakes cannot be avoided even with a very long observation time.[1]

We therefore prefer to give the results in the form of the apperception diagram.

III. Results Obtained with Contrast Size Diagrams (c. s. d.) and Apperception Diagrams (a. d.)

(1) *Comparison of twelve different methods of mass chest radiography.*

In order to compare the results of mass chest radiography as applied in different institutions, the perception curves of twelve working methods were plotted in a *c. s. d.* In every case the leader of the institution[2] in

[1] Moreover there is a marked individual difference, caused by psychological and temperamental influences, as can be seen from the diagram in fig. 16 and 18. For observer B 1 mistake is equivalent to 4 sec., for observer H 1 mistake to $2^1/_2$ sec. approximately.

[2] These experiments were carried out during a trip in Scandinavia; I am very grateful for the helpful co-operation of my colleagues there.

which the examination took place was asked to make 6 pictures of the phantom, 3 for a thin patient (72 mm bakelite) and 3 for a middle-size patient (92 mm bakelite). The choice of exposure time and tension was left to the operator, asking an exposure for a patient of 18, 19 and 20 cm thorax-diameter for the thin patient and of 22, 23 and 24 cm for the bigger one. The object plate was placed directly against the screen (except in No. 11, in which case a magnified picture was made, under

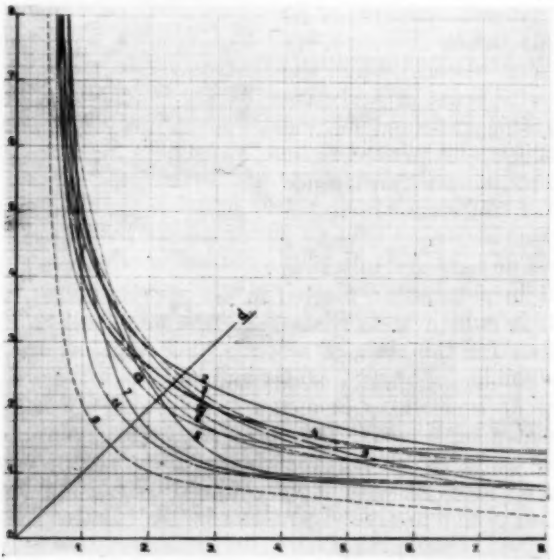


Fig. 8. Contrast-size diagrams of Mass-chest methods in eleven institutions (72 mm bakelite, $\pm$ 18 cm thoraxdiameter).

conditions that will be discussed later). The object plate did not move in these observations; as a consequence the results of methods using a long exposure time over-estimate the resolving power of these methods when used for real lung pictures.

Fig. 8 shows the diagrams. For the estimation of the perception curves the best exposure for a special condition was chosen.

From these perception curves it can be concluded that a marked difference exists between the methods used. The crossing of each of the curves with line d. indicates the smallest perceptible equal-sized cylinder. From the difference in shape of the curves it is clear that the measuring of this special item, without estimating the total perception curve, cannot

ive a completely satisfactory impression of the resolving power over the whole range that is of interest in roentgen diagnostics of the lungs. The question was raised in how far it would be preferable to characterize the results in a given case as a percentage of some »ideal» method, say contact roentgen picture. HILLEBOE and MORGAN (10) for example give the following relative effective ability of various radiographic materials to record detail:

Table 1

(quoted from HILLEBOE and MORGAN).

Relative Effective Ability of Various Radiographic Materials to Record Detail.

Film.	Relative effective ability to Record detail
14 × 17 in. celluloid film exposed with Patterson Par-Speed screens	100 %
4 × 5 in. photofluorographic film exposed with a grid	40 %
70 mm photofluorographic film exposed with a grid	35 %
14 × 17 in. sensitized paper film exposed with Patterson Par-Speed screen	35 %
35 mm photofluorographic film exposed with a grid	20 %
4 × 5 in. photofluorographic film exposed without a grid	20 %
70 mm photofluorographic film exposed without a grid	17 %
35 mm photofluorographic film exposed without a grid	10 %

This method of comparison, though attractive at first sight, has many disadvantages. For instance it does not give an impression of the type of the curve and what is still more important, the ideal standard may change by technical improvement. We therefore prefer to compare the absolute results as indicated in the perception curve (c. s. d.).

(2) *Results of fluoroscopy.*

The perception curve estimated with the contrast size phantom gives an excellent impression of the influence of using a diaphragm on the perception of detail. Changes in the conditions of fluoroscopy (mA, K. V., focus size, screen) give a direct change in the c. s. d. and it is relatively easy to find out the optimal conditions for screening.

There is, however, another application of this method in the field of fluoroscopy: the selection of doctors and technicians in regard to their adequacy for this type of work. Fig. 9 gives an idea of the results of a number of observers. A quite marked divergence was found in these cases. The persons A and B are hardly suitable for detailed fluoroscopic work. Further experiments should establish the typical standard curve of normal individuals under different conditions. It is advisable to estimate these perception curves as a routine criterion for the selection of assistants

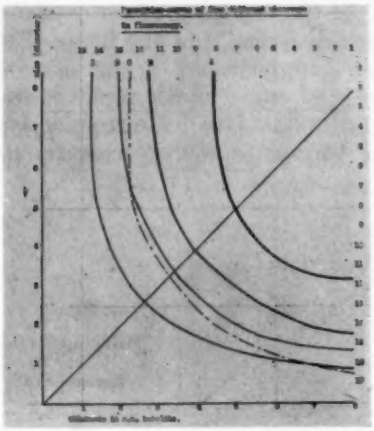


Fig. 9. Perception-curves of five different observers in fluoroscopy.

for roentgen work.[1] When necessary for detailed diagnosis, an apperception diagram may be added.

(3) *Some factors influencing the results of mass chest radiography.*

The following factors are considered:

(a) method of viewing,
(b) type of film,
(c) influence of geometrical or roentgenological magnification (object nearby focus, screen at a certain distance from object).

These experiments are discussed only to give an impression of the type of problems that can be solved with the methods described; they are not at all complete and do not give a general review of the problem as a whole. The factors a and b do not need any further explanation. The third factor, however, *i. e.* geometrical magnification, requires a more detailed discussion.

When we move the object in a direction away from the screen to the focus, keeping the distance screen to focus unchanged, the effect will be:

(a) the geometrical unsharpness becomes larger,
(b) contrast improves, because a greater part of the secondary rays does not reach the screen.

Now, in fluoroscopy and mass chest radiography the screen unsharpness is one of the important limiting factors for the resolving power of the roentgen method. This screen unsharpness has the same absolute value in both cases illustrated in fig. 10. The relative disturbing influence of this unsharpness on the screen image thus becomes smaller by a roentgenological magnification. It will depend on the relative importance of the factors: geometrical unsharpness, screen unsharpness and contrast, what will be the result on the image and the resolving power of the roentgen method used.

The experiments were made with a Philips Mass Chest apparatus provided with a mirror camera and making use of a 45 mm film (actual

[1] A perception curve can of course also be estimated, without making use of a roentgen apparatus. It is probable that this will be of value for the selection of persons for fine visual work in industry. Methods for this purpose based on the same principles as those described in this chapter will be published elsewhere.

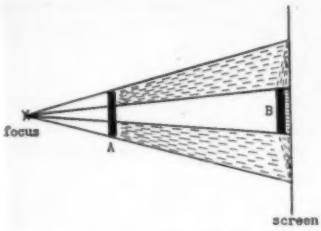


Fig. 10. Scheme showing the diminution in quantity and intensity of secundary rays in the case of röntgenological magnification (object A) as compared with the normal picture (object B)

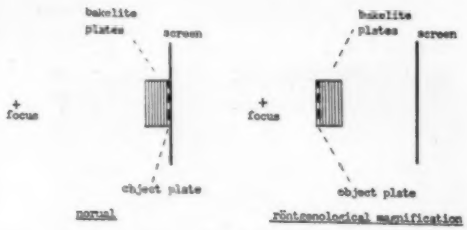


Fig. 11. Position of phantom in the case of a normal picture and a roentgenological magnification.

size of the picture 40 mm). The phantom was placed with the object plate directly against the screen (normal picture) or at a distance of 30 cm. from the focus, as is indicated in fig. 11.

The magnification was 2.8 diameters (focus to screen distance 85 cm). The tube used has a rotating anode with a focus of 1.4 mm. For every particular photographic condition 3 exposures were made (72 mm bakelite: 16, 18 and 20 cm thorax diameter; 92 mm bakelite: 22, 24 and 26 thorax diameter). All pictures were made on the same film and thus developed under exactly the same conditions (normal roentgen developer). The perception curve was plotted in every case and the best result of the three exposures under the same conditions is reproduced in the results. The apperception diagram is plotted from the data of all exposures. Results are measured by two different observers (H and B).

The films have been viewed in three different ways:

(a) projection on a white screen (practically without grain) in a size 35×35 cm,
(b) projection on the same screen in a size 15×15 cm,
(c) through a simple viewer giving a linear magnification of 1.8 diameter.

These different methods of observation are marked in the figures. Now and then we changed the brightness of the image in the case b, because it was found to be too high in certain cases.

Most of the experiments were carried out with two different kinds of films: Scopix and Scopix micro (Gevaert). The latter film has a 3—4 times less sensitivity than the normal scopix, gives a better contrast and has a smaller grain (unsharpness). Some of the results are composed in the following set of diagrams (figs. 12 to 21).

The significance of the marks used in the apperception diagrams, is as follows (see fig. 14—19):

	Scopix	Scopix micro	Scopix magnification	Scopix micro magnification
Viewer 1.8 ×	○	○	x	x
35 × 35 cm projection	●	●	+	+
15 × 15 cm projection	❙	❙	v	v

In fig. 17 and 19

x
+
v

The result may be summarized as follows:

(a) The three methods of viewing do not give a significant difference in the results of the c. s. d. Mostly it is not possible to draw any definite conclusion from the results obtained. In fig. 12 one experiment is shown in which this difference was clear enough to draw perception curves that show a deviation for special conditions. The apperception diagrams allow that the same conclusion may be drawn. The points representing observation with large projection (●), small projection (❙) and viewer (○) do not show any systematic tendency (figures 14, 16, 17, 18 and 19). *We therefore may draw the conclusion that the different methods of viewing, when fulfilling* normal standards of quality, are approximately equivalent, in so far as the perceptibility of detail is concerned.[1]

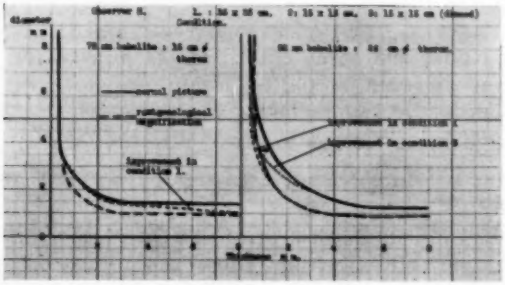


Fig. 12. Contrast-size diagrams. Comparison of different methods of projection.

(b) The type of film has a distinct though not spectacular influence on the results.

The c. s. d. show a better result for scopix micro, not only in the normal picture but as a rule also in the roentgenological magnification.

[1] The only apparent difference is caused by the difference in brightness of the picture in projection at different sizes. This may cause some improvement in results when viewing overexposed films in small projection.

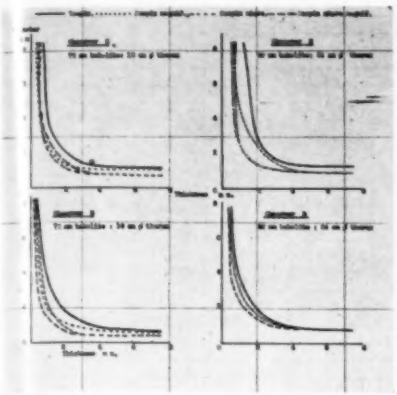


Fig. 13. Contrast-size diagrams. Comparison different films, normal picture and roentgenological magnification.

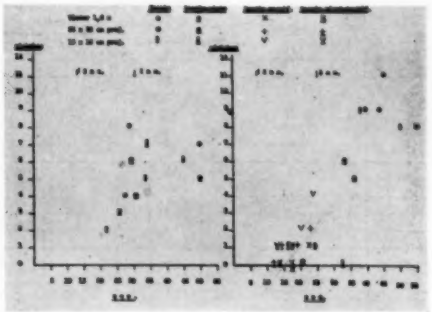


Fig. 14. Apperception Diagrams. Comparison of films Scopix and Scopix-micro in normal picture and roentgenological magnification, seen with different methods.

The results of the two observers H and B are in fair accordance with one another on this point (figure 13).

The following table summarizes the smallest visible equal-sized cylinder in these conditions (taken from the data of figures 13, 20 and 21):

Table 2

	Thin thorax		Middle size thorax	
	Normal	Magnification	Normal	Magnification
Scopix	2.1	1.6	2.2	1.7
Scopix micro	1.6	1.4	2.0	1.7

It can be concluded that micro scopix film gives a slight improvement in the results as compared with scopix, when measured in the c. s. d. Now it is quite interesting to note that these small differences have already a very marked influence on the apperception, as is clearly shown in the apperception diagram of figures 14, 15, 16 and 18. This shows that the apperception diagram is the more sensitive method of the two described here.

(c) The influence of geometrical or roentgenological magnification is shown very distinctly in the perception curve of figures 12, 13, 20 and 21 and gives still more spectacular results in the apperception diagrams of figures 14, 15, 16, 17 and 19 (see also table 2). When judging the results of the apperception diagram we have to consider that the normal reading time of the phantom under ideal conditions

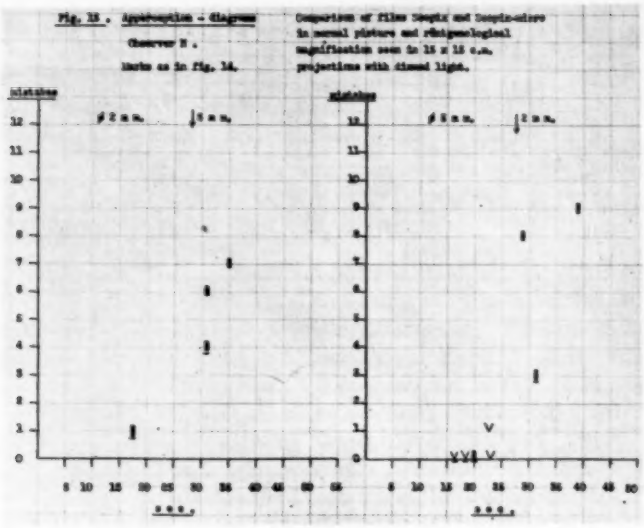


Fig. 13. Apperception - diagram
Observer B.
Marks as in fig. 14.
Comparison of films Doepfe and Doepfe-olive in normal picture and rötgenological magnification seen in 15 x 15 c.m. projections with direct light.
relatives
relatives

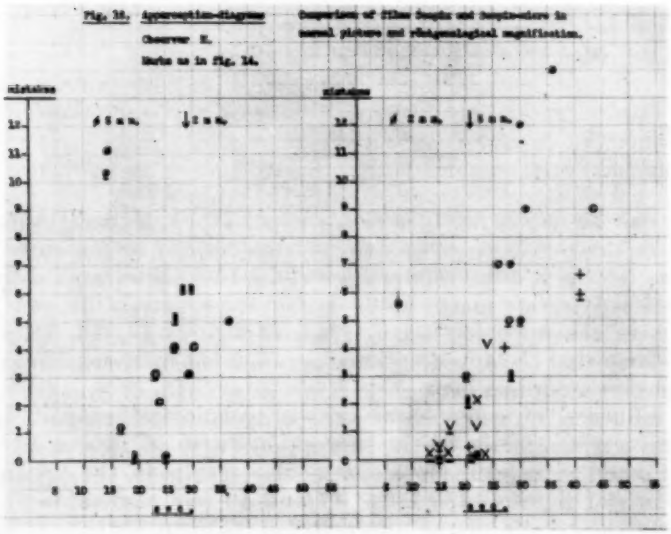
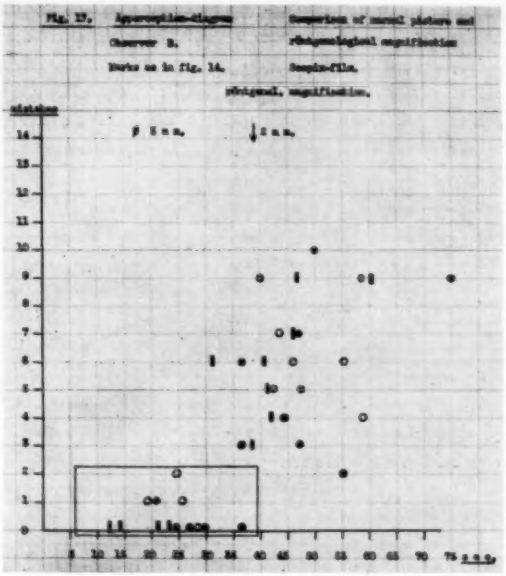
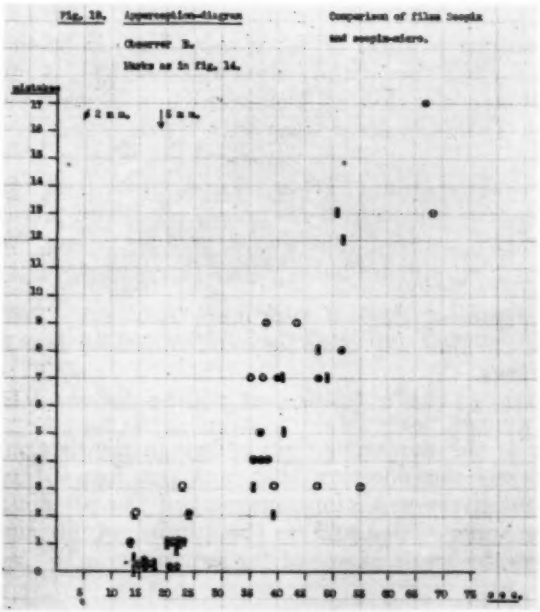
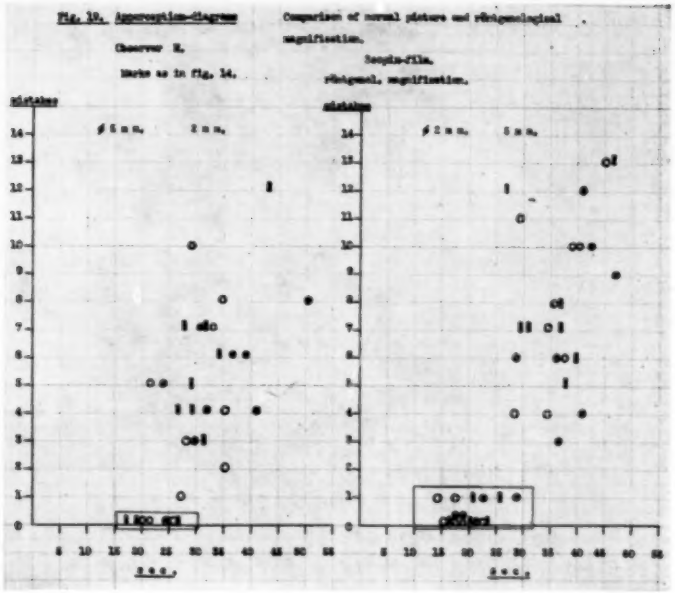


Fig. 14. Apperception-diagram
Observer E.
Marks as in fig. 14.
Comparison of films Doepfe and Doepfe-olive in normal picture and rötgenological magnification.
relatives
relatives







(contact roentgen picture, bright viewing box) is 10 to 12 sec. This means that for the size of the holes examined (2 × 5 mm and 5 × 2 mm) the difference with ideal conditions in a contact picture is relatively small. This is in accordance with the fact that, measured with a *c. s. d.*, the smallest visible equal-sized cylinder in a contact roentgen picture is of the order of 1.0 to 1.2 mm, which is no great difference with the figure obtained in a magnified miniature picture (1.4 mm). This small difference would, no doubt, give a greater difference in the apperception diagram if smaller holes (borderline cases) were used.

The improvement obtained with geometrical magnification is much more impressive than any other we could realize by changing our technical expedients.

(The causes of this improvement will be discussed in section V.)

Comparison of the numerous data shown in the diagrams, makes it possible to answer the question that was put forward regarding the influence of a relatively small improvement of the perceptibility on the time needed for apperception and on the number of mistakes made.

Table 3 gives the result of one of the experiments:

Table 3

Observer	Condition	Smallest visible detail	Holes depth 2 mm diameter 5 mm (equal-sized cylinder)		Holes depth 5 mm diameter 2 mm (equal-sized cylinder)	
		mm	sec. (average)	mistakes (average)	sec. (average)	mistakes (average)
H	normal	2.1	35	5.4	39	8
	magnification	1.7	24	0	21	0.5
B	normal	2.0	49	5.5	44	7
	magnification	1.5	28	1	19	1

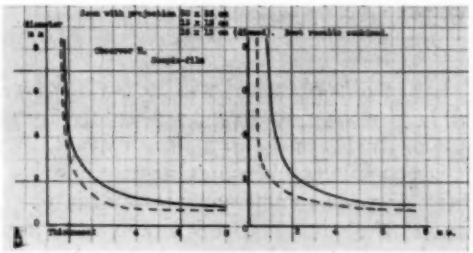


Fig. 20. Contrast-size-diagram. Comparison of normal picture and roentgenological magnification, seen with projection.

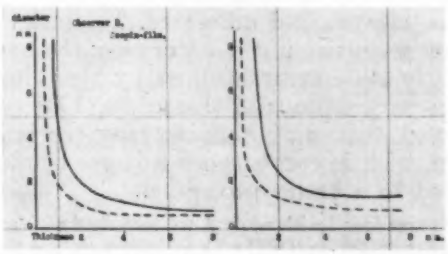


Fig. 21. Contrast-size-diagram. Same as fig. 20, seen with viewer.

From these figures it is obvious that a relatively small improvement of 0.5 mm measured as the smallest visible detail results in a diminution of the observation time of 30—45 % and prevents most of the mistakes, thus leading to an approximately faultless interpretation of the test.

With the set-up described for studying the influence of movement-unsharpness an endeavour was made to form a quantitative idea of the influence of a given unsharpness on the perceptibility of detail. It should

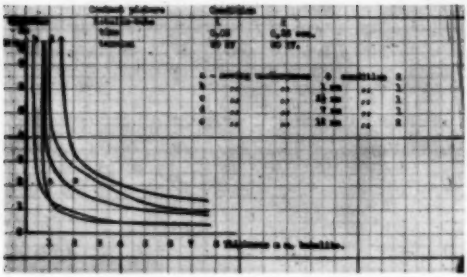


Fig. 22. Contrast-size-diagram. Influence of motion-unsharpness on perceptibility of detail.

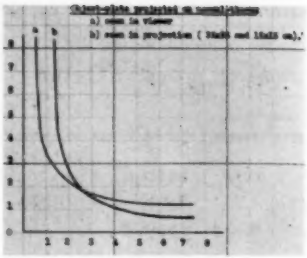


Fig. 23. Contrast-size-diagram.

be borne in mind that results obtained with a device of a simple structure such as that used here does not give an absolute measurement of the disturbing influence of unsharpness in a lung picture.

Nevertheless it is possible to obtain an approximative impression concerning that influence under experimental conditions.

In this experiment the pictures were made with a normal roentgen apparatus with rotating anode and a normal size contact film. The results are plotted in 5 curves of the c. s. d. in figure 22. From these experiments it may be concluded that the results in a picture without movement-unsharpness (a) and one with an added movement-unsharpness of 1 mm do not show any marked difference. The image is unsharp with less contrast but of larger size in the latter case; the two first mentioned influences apparently are counterbalanced by the third. This may be to a certain extent in accordance with the results of HENNY and CHAMBERLAIN,[1] who observed that during fluoroscopy the bringing of the eye close to the screen, with in consequence a larger but unsharp image on the retina, can lead to a better perception.

The best result we ever found with a *c. s. d.* was obtained with some pictures made in co-operation with Dr. MARSTRANDER (Oslo) with a *planigraph*. The object plate was placed exactly in the cutting plane and even the smallest object (0.5 × 0.5 mm) could be detected. This is an interesting fact, because it shows that the perceptibility of detail is very good in planigraphy when the exact cutting plane is considered.

As a last experiment in this section must be mentioned a kind of cross-experiment in which the bakelite objective plate is placed in front of the thorax of a normal (thin) patient. Some pictures were made in order to have a fair chance for an appropriate projection of the holes in a free lung space. Figure 23 shows the result, from which it can be taken that

[1] l. c.

at least the order of magnitude of the smallest perceptible detail is very well in agreement with the experiments when using the complete bakelite phantom.

IV. Quality Control of Roentgen Pictures

The methods described in the preceding chapters enable us to analyse the relative value of different roentgen technical methods, measured by the resolving power and the phenomena depending thereupon (apperception). The devices used for this purpose allow a rather quick examination; neither the size of the apparatus nor the interpretation of results, however, make it suitable *for a regular check on the technical qualities of roentgen pictures.*

WEIDMAN and KIEFFER (11) recently published a method for quality control of all roentgen pictures of the thorax. The principle of this method is a control of contrast qualities carried out by means of copper steps, in order to ascertain a constant quality in serial films. The use of this little phantom certainly makes it possible to aim at a certain contrast curve (BRONKHORST) and to reach a good constancy, but it is not possible to draw adequate conclusions concerning the effect of different contrast qualities of every picture on the perceptibility of detail in every particular case. However, this is exactly what one wants to know when comparing a series of pictures of the same patient. In any case of difference between two pictures of the same patient, we should know exactly *whether and in how far* this difference is caused by changes *in the patient* (reactivation of improvement) or by *technical factors.*

For this purpose a *quality control phantom* was constructed, based on the same principles as those developed in the preceding sections. The size of this phantom must be small enough to find a place at the upper end of the film, at both sides of the neck, above the shoulders.

Fig. 24 shows the phantom and in fig. 25 a reproduction is given of a lung picture with the phantom in situ.

The phantom is composed of two sets of 5 aluminium steps, from 4 to 8 mm and 9 to 13 mm thickness. In view of the small area available

Fig. 24. Quality-control phantom: Aluminium steps with bakelite balls.

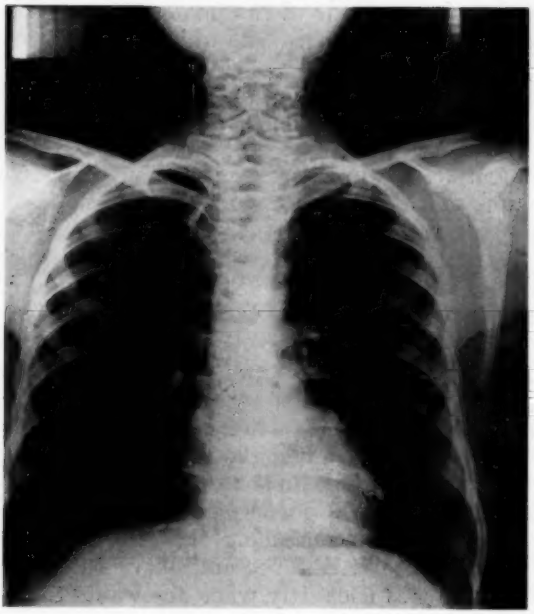


Fig. 25. Lung picture with quality-control phantom in situ.

for the application of the phantom it is necessary to use a metal phantom in which case aluminium has an atomic number that is best fitting the purpose. On each step five objects are fixed, consisting of balls of bakelite with a diameter of 4.0, 2.8, 2.0, 1.4 and 1.0 mm. At one side a set of 5 steps of copper (thickness 0.2, 0.3, 0.4, 0.5 and 0.6 mm) is added (the same as used by WEIDMAN and KIEFFER) in order to have a further control of contrast qualities. At the other side a lead strip is placed as a test of dark-room technique and to estimate the fog.

With this phantom it is very easy to compare a certain area of the lung picture with one of the aluminium steps with equal density and read from this the smallest detail that can be observed (as a single nodus under ideal circumstances of homogeneous background). Working in this way we can always aim at a certain resolving power, as is indicated in the aluminium phantom and draw conclusions about the quality and the resolving power of each particular picture. This procedure gives satisfactory results and it could be shown that the aluminium step having a density equal to that of the free lung field (*i. e.* between the ribs) with an adequate density shows 4 and in optimal conditions 5 objects. This

would indicate that the smallest visible ball is in the order of 1.4 to 1.0 mm. This value is in very good accordance with the results obtained with the c. s. d., the smallest visible cylinder being 1.1 mm.

There is, however, one objection against this interpretation: the use of aluminium steps does not allow of direct conclusions being drawn about the conditions of visibility of details in the thorax (or in a bakelite phantom). The pictures of thin and thick patients are usually made with very different tensions and the changes in absorption of aluminium by changing the tension are different from those of bakelite or the human body under the same conditions.

The following experiments were carried out to settle this problem. Two phantoms were made, one of 10 aluminium steps of 4 to 13 mm and the other of 10 bakelite steps of 4 to 13 cm. On each step 5 objects (bakelite balls of 4.0, 2.8, 2.0, 1.4 and 1.0 mm) are fixed. From both phantoms a set of pictures was made with the Rotalix lung apparatus.

Table 4 gives the different conditions of exposure.

Table 4

Without grid			With grid		
Exposure	mAs	KV	Exposure	mAs	KV
1	40	47			
2	40	51			
3	40	55			
4	40	59	4	40	59
5	40	63	5	40	63
6	40	67	6	40	67
			7	32	72
(exposure-time 0.08 sec.)			8	32	77
			9	32	81

In this way 120 pictures of one aluminium step and 120 pictures of one bakelite step were at our disposal. From each of these steps it was noted how many objects were visible. For this purpose 3 different lighting boxes were used with a brightness of 0.20 (a) 0.25 (b) and 9.4 (c) stilb[1]. The first brightness (a) was realized in a large viewing window of 4×1 M, in which glare was only partly prevented, whilst in the other two conditions (b and c) only a small field of $\pm 10 \times 10$ cm or smaller was used. The results of these different conditions were estimated.

During the examination of the pictures it appeared that in many cases it was the density (blackening) that in the first place determined the results of perceptibility, at least in the majority of the pictures. Therefore the density of each step was measured. From these data the following graphs could be plotted (figures 26 and 27) in which the ordi-

[1] 1 stilb = 10,000 candle-power per square meter.

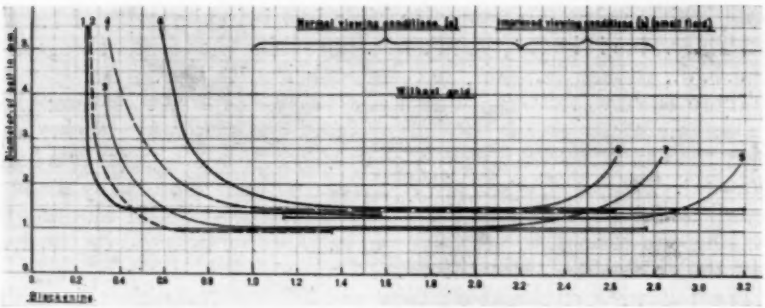


Fig. 26. Comparison of Aluminium and Bakelite quality control-phantom for different exposures and different brightness of negatoscope. Pictures made without grid.

1. Al. I and II.
2. Bakelite I and II.
3. Al. III and IV.
4. Bakelite III and IV.
5. Al. V and VI.
6. Bakelite V and VI.
7. Al. III and IV.
8. Bakelite III and IV.

nate gives the size of the objects seen and the abscissa represents the blackening.

From these curves the following conclusions can be drawn:

(1) A density of more than 2.7—2.8 gives bad results, even when a bright viewing box (0.25 stilb) with small field (b) is used; a much higher brightness (9.4 stilb (c)) does not give an appreciable improvement. The results of this last condition therefore are not plotted in the graphs.

(2) In the range of density of 1.0 to 2.2—2.5 the curves for aluminium and bakelite practically coincide when viewed under normal conditions (a). The results with low tension are as a rule better than those with high tension.

(3) The results for aluminium and bakelite in the zone of density of 0 to 1.0 deviate; this deviation is much more marked when no grid is used.

(4) The total range of blackening in which the curves of aluminium and bakelite phantoms coincide is larger when a grid is used. The grid we use (25 lines per cm), however, has a slight disturbing effect on the visibility of the smallest details; perception of 1 mm objects is difficult under these conditions.

(5) The curves show that in the zone of low density (*i. e.* thicker objects) the results with bakelite remain (as a rule) clearly on a lower level than those with aluminium; apparently the secondary rays cause a less marked contrast; this is not, however, the case when with relatively thin objects a low tension (47—51 KV) is used.

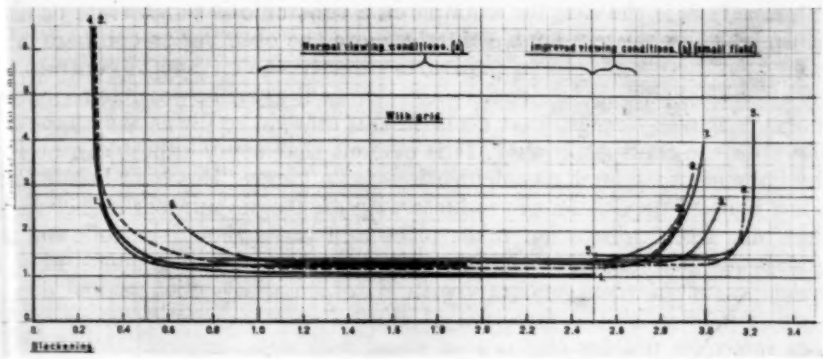


Fig. 27. Comparison of Aluminium and Bakelite quality-control-phantom for different exposures and different brightness of negatoscope. Pictures made with grid.

1. Al. IV and V.
2. Bakelite IV and V.
3. Al. VI and VII.
4. Bakelite VI and VII.
5. Al. VIII and IX.
6. Bakelite VIII and IX.
7. Al. VI and VII.
8. Bakelite VI and VII.

(6) The best results are obtained when an optimal blackening is caused by a low exposure (thin objects).

(7) The above mentioned conclusions suggest that a grid should be used when an exposure No. 5 (see table 4) would be necessary without grid (40 MAs and 63 KV).

(8) The range of density from 1.0 to 2.2 (cf. 2) allows of optimal results with normal viewing conditions (a). *The smallest perceptible detail in the aluminium phantom is in this case nearly identical with that in a bakelite phantom.*

When it is necessary in a special case to draw conclusions concerning the perceptibility in a zone of less density *e. g.* behind a rib (-crossing), the curves should be consulted before drawing a conclusion.

The routine use of this aluminium phantom makes it easy to decide instantly whether a given density in a picture is viewed with adequate conditions (brightness, glare), by counting the number of objects in the step with equivalent density in the phantom.

The greatest advantage of the routine use of this phantom, however, is the obvious effect of easily aiming at a high standard quality of all pictures made and of the possibility to get a more or less quantitative impression of the influence of technical factors on the visibility of detail. This last fact is of great importance when patients have to be regularly

examined, as is the case for example in a tuberculosis sanatorium or dispensary. The phantom enables furthermore the observer to compare and even to a certain extent to »measure» directly the change in contrast of an infiltration; when the size does not change it must be possible to follow up the chemical changes that occur in this area, in so far as they have an effect on the contrast quality. It is evident that every expert can notice the large changes, such as calcifications, at a glance. But long before this a less marked deposition of products with an atomic number higher than that in a fresh infiltration takes place and these should be followed as exactly as possible. Proclaiming this as a logical consequence of the development of roentgenography in roentgen diagnostics means doing a cautious step in the direction of *clinical roentgenometry instead of the very subjective judging that is now usual with many experts.*[1]

The regular quality control of importance in »normal» roentgen methods is evident in the case of mass chest radiography. For this purpose the same method can be used, though it would perhaps be preferable to adapt the size of the objects to the special achievement of the mass chest apparatus used. Our experience showed that the smallest perceptible object in the normal mass chest picture was between 2.8 and 2.0 mm; only under favourable conditions the ball of 2.0 was visible.

V. Measurement of the Screen Unsharpness

Size, sharpness and contrast determine the perceptibility of detail. The unsharpness of the screen is one of the most important factors in fluoroscopy that impede the results. This is the reason why the method of roentgenological magnification gives improvement of results in fluoroscopy when a sharp focus is used. When working with a special tube containing a rotating anode with a focus of 0.3 mm it was possible to enlarge the roentgen image on the screen 5 diameters without a disturbing geometrical unsharpness (12). It was expected that this improvement would fail when a normal size focus was used.

A simple orientation showed, however, that better results of screening were obtained when using a focus of 1.2 mm and a magnification of 2 diameter. Though further experiments would be needed to give the exact explanation of this fact, it was the starting point for our experiments with roentgenological magnification in mass chest radiography.

[1] We have also tried to use a phantom with the same bakelite balls fixed on a thin layer of cellon, placing this in the free lung field of the patient. The results were not satisfactory because of the difficulty to get a good projection, without disturbance of the greater shadows (ribs, vessels etc.). Moreover the smallest details (1—2 mm) get lost between the normal lung pattern.

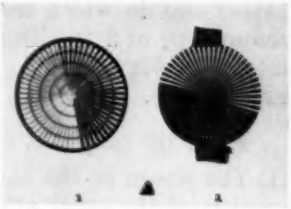


Fig. 28. Determination of screen-unsharpness with star phantom.

1. roentgen picture of the screen (see scheme fig. 30).
2. normal-size roentgen pictures of star on film.

Further analysis of the phenomenon made it necessary to dispose of a simple method allowing direct conclusions to be drawn. Metal gauze used as a phantom gave some impressions but it did not give good measurable data. A fair solution was found in a phantom composed of metal strips in the shape of a star[1] (fig. 28). This star is composed of 120 sectors of 3 degrees, of which 60 are of copper and 60 of paper. The thickness of the metal strips is different in each quadrant: 0.5, 1.0, 2.0 and 3.0 mm. The radius is 2.5 cm; four circles of metal wire with a radius of 0.5, 1.0, 1.5 cm indicate the place where the distance between two metal strips is approximately 0.25, 0.50, 0.75 and 1.00 mm, the outer circumference representing a distance of 1.25 mm. With this simple phantom it is very easy to estimate the smallest distance at which the strips can be seen apart. This enables us to determine the effects of roentgenological magnification under different circumstances. Fig. 29 shows the result of an

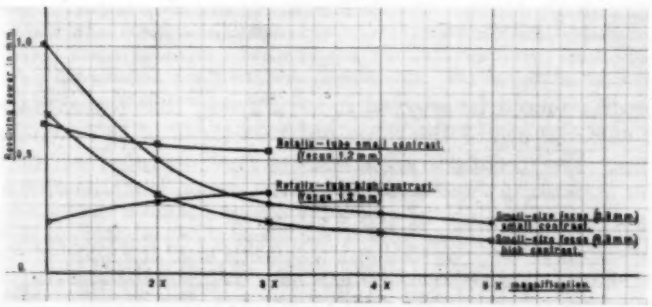


Fig. 29. Determination of resolving power with star phantom. Influence of roentgenological magnification with normal-size focus (1.2 Rotalix-tube) and small size focus 0.3 mm.

[1] This suggestion was given to us by Dr. M. LINDGREN from Lund, who visited us and told us about his experiments with a lead star (JEWELL-FRANKE) as a method of measuring the resolving power of mass chest radiography. I am very much indebted to Dr. LINDGREN for this idea.

experiment in which the results are compared of the magnification in fluoroscopy of 3 × with a 1.2 mm focus and a magnification of 5 × with a focus of 0.3 mm. Two different screens were used in these two sets of experiments.

From the graphs it can be concluded that:

(1) The screen in the small focus apparatus is of an inferior quality to that of the other apparatus;
(2) Magnification with the 1.2 focus gives no improvement at all in this case, apparently because no scattering rays of any importance are present and the object gives a marked contrast;
(3) Magnification with the 0.3 focus gives a marked improvement up to an enlargement of 3 diameter.

It is clear, therefore, that the good results obtained in mass chest radiography depend mainly upon an improvement of contrast and not on the magnification.

With the star phantom an easy method is obtained for determining screen unsharpness in the following way. A number of roentgen pictures of the star were made. We then placed the metal star at the tube side of the screen and one (or some) of the pictures at the opposite side (fig. 30).

Fig. 30. Scheme of operation for determination of screen-unsharpness with star phantom.

These pictures should be selected in such a way that the average brightness and contrast are of the same order as those of the roentgen image of the star.[1] The roentgen apparatus is now operated at an intensity normal for fluoroscopy and a picture of the screen is made with a camera. Fig. 28 gives an example of the method.

The difference in the »resolving power» shown in the two stars is caused by the screen unsharpness and is of the order of 0.10—0.20 mm. This method may not give equally exact results as, for example, the method of KLASENS (13), but it has the advantage of simplicity and may be helpful in selecting good screens for the purpose of mass chest radiography.[2]

[1] When necessary we can change the brightness of the objects by using a filter.
[2] Apart from the unsharpness, the brightness of the screen should be measured.

Acknowledgement

These experiments were made possible thanks to the support given in the viewing and judging of the numerous pictures by Dr. D. HINRICHS and H. C. BURGER (med. stud.)

SUMMARY

The importance of the determination of the resolving power of a roentgen method is discussed. Methods are described by which it is possible to measure this resolving power under different conditions in lung roentgenology (fluoroscopy, contact picture, miniature picture). The influence of the resolving power on the accuracy and the time of perception are studied. It is shown that a relatively slight improvement in the resolving power has a very marked effect on the time needed to observe the details in a picture. A method is described for regular quality control in routine lung roentgenology. The predominant influence of the screen unsharpness in mass chest fluorography is mentioned and a method described for a simple estimation of this unsharpness.

ZUSAMMENFASSUNG

Es wird die Bedeutung der Bestimmung des Auflösungsvermögens im Röntgenverfahren erörtert. In diesem Zusammenhang werden mehrere Verfahren besprochen, die es gestatten, dieses Auflösungsvermögen in der Lungenröntgenologie (Fluoroskopie, Kontakt- und Schirmbildaufnahmen) unter verschiedenen Arbeitsbedingungen zu messen. Es folgt eine Untersuchung über den Einfluss des Auflösungsvermögens auf die Genauigkeit und die Wahrnehmungszeit, und es wird nachgewiesen, dass eine verhältnismässig geringe Verbesserung des Auflösungsvermögens sich in sehr beachtlicher Weise auf die für die Beobachtung der Bilddetails erforderliche Zeit auswirkt. Es wird ein Verfahren beschrieben zur regelmässigen Qualitätskontrolle in der täglichen Lungenröntgenologie. Die besondere Bedeutung der Unschärfe des Fluoreszensschirms beim Schirmbildaufnahmen wird betont und ein Verfahren beschrieben, das auf einfache Weise eine Bewertung dieser Unschärfe ermöglicht.

RÉSUMÉ

L'importance de la détermination du pouvoir de résolution d'une méthode de rayons Roentgen est étudiée. Des méthodes sont décrites dans lesquelles il est possible de mesurer ce pouvoir de résolution dans différentes conditions d'examens roentgenologiques des poumons (fluoroscopie, image par contact, image miniature). L'influence du pouvoir de résolution sur la netteté et sur le temps de perception est mesurée. Il est montré qu'une amélioration relativement faible du pouvoir de résolution a un effet très marqué sur le temps nécessaire pour observer les détails de l'image. On décrit une méthode pour un contrôle de qualité régulier dans l'examen roentgenologique courant des poumons. L'influence prédominante du défaut de netteté de l'écran est signalée dans la radiophotographie miniature du thorax et on décrit une méthode pour évaluer d'une façon simple ce défaut de netteté.

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RELATION BETWEEN THE RADIATION DOSE TOLERATED BY THE SKIN AND THE DISTANCE OF THE RADIANT SOURCE FROM THE SKIN[1]

by

Josef Klumpar, D. Sc.

In general, during both roentgen and radium therapy the surface dosage is without further consideration taken to be the skin dosage In deep roentgen therapy this procedure introduces practically no error As regards most radium therapy, however, the case is far otherwise, since we have almost invariably a small distance only between the source of radiation and the skin, varying from few millimetres to several centimetres. In this case it is not possible to neglect the drop in intensity of radiation with distance, which is the more rapid the nearer we are to the source. Under these conditions a given surface dosage does not always correspond to the same biological reaction. We cannot, for example, specify a given surface dose as the maximum dose tolerated by the skin without risking undesirable changes. Here and elsewhere in this paper, when speaking of the normal permitted reaction, what is meant is the state between epidermitis sicca and epidermitis exsudativa. This same measure of biological reaction may be produced by very different surface doses, whose values depend upon the construction of the source, and that go to show that the decisive influence in this respect is exerted by the distance of the radiant source from the skin.

The Radiotherapeutical Institute of Praha-Bulovka has had many years experience in the surface application of radium sources, and, in course of time, has been able to determine, on purely empirical grounds the application period required to produce the normal skin reaction by means of various types of applicators. If the actual surface dosage corresponding to these various times of application is worked out, it is evident that the values thereof are by no means constant, and are, for the most part, much greater than we should have expected from experience

[1] Submitted for publication, March 10, 1949.

with roentgen treatment only. A closer examination of these figures shows a decided connection with the distance of the radium source from the skin, the dose tolerated by the skin being the larger (up to about 5 times the roentgen tolerance) as this distance gets smaller.

This leads readily to the conclusion that for the normal skin reaction as defined above the decisive factor is not the dose received by the skin surface, but that received by a certain »sensitive layer» lying at a depth of some millimetres below the surface. Without taking too much account of anatomical considerations, we may say on purely empirical grounds that this layer lies at about 4 mm below the skin surface. We must not, of course, overlook the fact that this conventionalisation, *i. e.* the introduction of the term »sensitive layer», involves a certain measure of inaccuracy, connected with the fact, that the sensitive points are distributed in space, and not on a mathematical plane. We have a sort of »biological centrum». Other connected considerations are, of course, the variability of biological material, of different individuals, natural resistence, varying qualities of different parts of the body, etc. This problem has already been dealt with in 1939 and 1941 by M. STRANDQVIST (1), who comes to much the same fundamental conclusions, although his source of radiation maintained a constant distance (4.5 mm) between the centre of the radium container and the skin, and varied only in size, *i. e.* in number of containers used. He recommends the intensity at a distance of 3 mm below the surface as a basis for stating dosage. Neither 3 mm nor 4 mm can be regarded as a definite and unchangeable figure; having regard to the variability of the material we must be satisfied with an approximate value suitable for use in the largest number of given cases, and with the largest number of types of applicators, with a large range of variation in distance of source. It should also be noticed here that in Strandqvist's experiments the distance effect was combined with the effect due to the variation of the size of the field.

Calculation of the Intensity of Radiation

The intensities of radiation at the skin surface and at a depth of 4 mm below it, as given in the descriptions below of the various sources of radiation used, have, for the most part, been obtained by calculation on the basis of graphs giving the variation of intensity of radiation with distance on a central axis perpendicular to the axis of the radium container. The curves applying specially to the containers used in the Radiotherapeutical Institute, are themselves derived from two curves.

For near points, where it is necessary to take into account the dispersion of the radium within its container, the intensity has been cal-

culated on the basis of the equation derived by R. SIEVERT (2). According to SIEVERT we may assume, with sufficient accuracy for our purposes that the radioactive material, actually distributed in the form of a cylinder of dimensions equal to the internal dimensions of the radiophore, is uniformly distributed along the straight line forming the axis of this cylinder. The dimensions of our radiophores are given in Table I. The intensity I of radiation at a point distant a from the centre of the applicator is given by

$$I = k_\varphi \cdot \frac{2P}{v \cdot a} \cdot F\left(\frac{v}{2a},\ \Sigma \mu_i \cdot d_i\right) \ldots\ldots\ldots\ldots \quad (I.)$$

P is the content on radium in mg, v is the height of the cylinder of radioactive substance, *i. e.* the length of its axis. The arithmetical value of the function F, defined as

$$F = \int_0^{\varphi_m} e^{-\frac{\Sigma \mu_i d_i}{\cos \varphi}} \cdot d\varphi \quad \left(\operatorname{tg} \varphi_m = \frac{v}{2a}\right)$$

may be found for the appropriate values of $\frac{v}{2a}$ and $\Sigma \mu_i \cdot d_i$ for each point from the tables worked out by R. SIEVERT (2). $\Sigma \mu_i d_i$ characterizes the filter, μ_i being the absorption coefficient of the medium i, and d_i being its thickness. In our case this term reduces to the product of the absorption coefficient of platinum ($\mu_{Pt} = 1.85 - 1.92$ cm^{-1}) and the thickness of the wall, equal to 0.1 cm. If we wished to take absorption in the tissues into account, we were obliged to add to this a further product, different for each point, equal to the product $\mu_t \left(a - \frac{p}{2}\right)$, where μ_t is the absorption coefficient of tissue, lying between 0.091 — 0.084 cm^{-1} and p is the external diameter of the radiophore.

For more distant points it is no longer necessary to allow for the distribution in space of the radiant matter, since the error introduced by assuming a point source is inappreciable. At the limit $\operatorname{tg} \varphi_m \longrightarrow 0$ Sievert's equation takes on the simplified form of

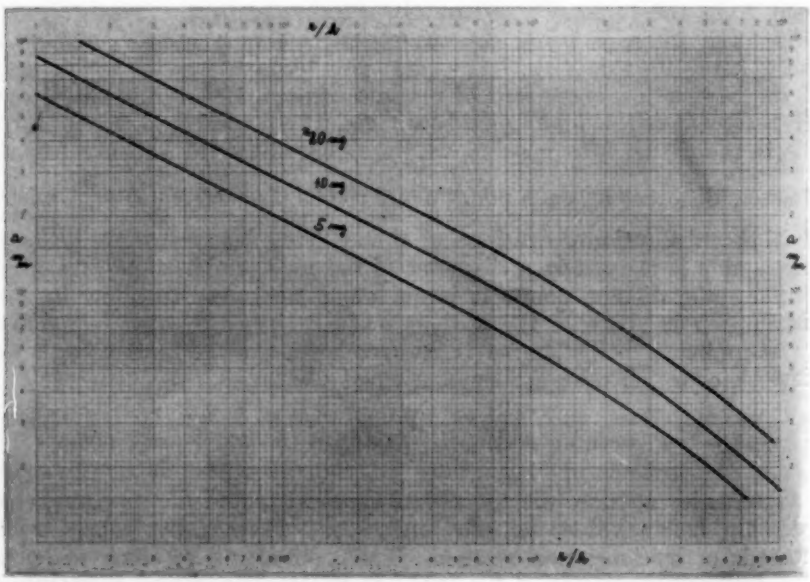
$$I = k_\varphi \frac{P}{a^2} \cdot e^{-\Sigma \mu_i d_i}$$

Intensities at more distant points thus calculated lie, however, considerably below values actually measured, whether by photographic methods or by ionisation methods. Thus, for example, using with our source a hard-wood cube of 5 cm side, after HOLTHUSEN and HAMANN (3) as a standard for radiographic measurement, placed between the sen-

sitive plate and the applicator (20.7 mg Ra, 1 mm Pt) we obtain by calculation an intensity of radiation of 3.6 r/hour. On the other hand the measured value obtained with an ionisation chamber is 5.05 r/hour, which is in good accordance with the statement's of MINDER (4) page 108. The difference between these two values is brought about by the fact that in calculation no account has been taken of secondary radiation. As measured, the drop in primary radiation produced by absorption in tissue is roughly compensated for by secondary radiation, so that we shall obtain smaller errors if, in our equation, we leave tissue absorption out of account. For more distant points (several centimetres) we may continue our calculations with the simple formula

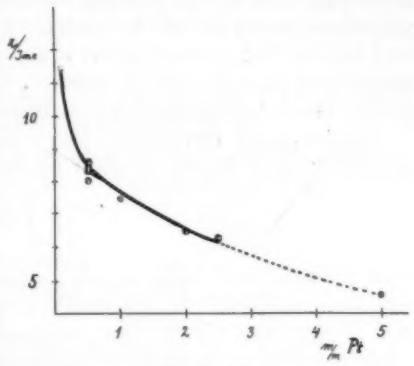
$$I = 7.5 \frac{P}{a^2} \text{ r/hour} \quad \text{(Filter 1 mm Pr)} \ldots\ldots\ldots \text{(II.)}$$

The final curves for our radium containers, giving the intensity of radiation from the surface of the container up to 10 cm, are produced by the combination of the two curves derived from the two formulae specified (I., II.), which meet one another reasonably smoothly at a distance of from 0.75 to 1.5 cm (graph I.).



Graph I

There is of course a certain uncertainty about the coefficient which is used to convert Imc units into r units. According to the mathematical method used in the derivation of the Sievert equation we need a value of k for zero thickness. Graph II. shows the dependence of $k = r/Imc$ on the thickness of the Pt wall of the container. The values measured by different authors are taken from (4) page 93 and (5) page 76. Owing to the non-homogeneity of the radiation from radium the absorption coefficient of platinum is dependent upon its thickness. For that reason we are not allowed to extrapolate this part of the curve of graph II. corresponding to small thicknesses to zero thickness *i. e.* to take an experimental value with unfiltered radium. Nevertheless it seems justifiable to extrapolate the almost linear portion of this curve corresponding to thicknesses of Pt between 1—2 mm in order to obtain the value for zero thickness. In this way we get from graph II. a most probable value for k_0 equalling to 9 r/Imc.



Graph II

We have also obtained approximately the same value by another mean. We may for example ascertain graphically the average thickness of platinum corresponding to a given point on the axis as connected with various points on the radiant axis of the radium container, the radiations from these various parts of the source passing through different thicknesses of platinum. From Kohlrausch's graph (see SIEVERT (2)) we find the absorption coefficient corresponding to this mean thickness of platinum, and then from the former graph II., the corresponding coefficient k_a. This and the required coefficient (for »zero filter») must fulfil the relation

$$k_a = k_0 \cdot e^{-\mu_{Pt} \cdot d_m}$$

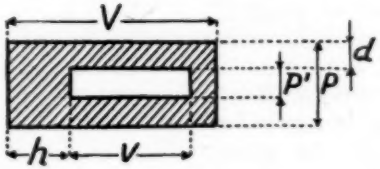
Table II. shows that the value 9 fulfils this requirement satisfactorily.

The intensity/distance curves obtained by these methods for our radiophores (graph I.) have been checked by both radiographic and iontometric measurements. Within the limits of experimental error good agreement had been found between the theoretical and experimental values. Only for the very shortest distances (a few mm) the average values for the radiographic measurements are consistently low by a few per cent. This is probably due to the so called non-saturation of the field due to

the fact that in the secondary radiation the backward emission plays a greater part than the forward emission. With the sharp intensity gradient existing at the nearer points the total secondary radiation is also less than at the more distant points where the intensity gradient is less. Our own radiographic experiments, in the course of which we have placed material in which secondary radiation was produced both before and behind the photographic emulsion, show that in this latter case the blackening is some 15 % greater. C. W. WILSON (5) page 39 has come to the same conclusion on the basis of iontometric measurements.

These small deviations have been ignored as of no practical importance; they do not exceed more than a few per cent.

Table I.



Radium content	mg	P	5	10	20
External length	cm	V	1.2	2	2
Internal length	cm	v	0.7	1.1	1.4
External diameter	cm	p	0.3	0.32	0.5
Internal diameter	cm	p'	0.1	0.12	0.3
Thickness of Pt wall	cm	d	0.1	0.1	0.1
Height of head	cm	h	0.4	0.5	0.5

Table II.

Calculation of k_0 (for 20 mg radiophore).

a	Average thickness of Pt d_m	μ_{Pt}	k_a from graph II. corresp. to average thickness	$e^{-\mu_{Pt} d_m}$	k_0 as calculated from relation $k_a = k_0 \cdot e^{-\mu_{Pt} d_m}$
cm	cm	cm^{-1}	r/Imc		r/Imc
0.25	0.17	1.85	6.8	0.735	9.2
1	0.13	1.90	7.3	0.78	9.2
5	0.1	1.92	7.5	0.827	9.04

Description of the applicators used

Applicators for Contact Radiotherapy. Tubes containing 5 mg of Radium are inserted into a plastic substance shaped to the surface of the part of the body to be irradiated, so that the average distance of the surface of the radiumcontainers from the skin is about 1 mm. With containers of a diameter of 3 mm this corresponds to an average distance of 0.25 cm between the centre of the radium container and the surface

of the skin. The wall of the radium tube is 1 mm Pt, and the length of the radiant column is 7 mm.

Nr. I. When applying a single 5-mg radium container in this way the intensity of gamma radiation directly below the centre of the container at the skin surface is 395 r/hour, and 4 mm below the skin surface, 85 r/hour. Time of application to obtain normal reaction ... 45 hours.

Nr. II. When thus applying a number[1] of radium containers distant cca 1.5 cm from one another we have

intensity under the central container at skin surface cca 460 r/hour
» » » » » 4 mm below skin surface cca 140 r/hour.

Time of application as above ... 30 hours.

Nr. III. A Celluloid applicator holding four 5-mg radium containers in a plane, parallel to one another and to the skin. The axes of the containers are parallel to each other and are 0.68 cm apart. Distance of the centres of radium containers from the skin, 0.85 cm.

Intensity under one of the central containers at skin surface 135 r/hour.
» » » » » » » 4 mm below 71 r/hour.

Time of application as above ... 45 hours.

Nr. IV. 40 mg radium 2 cm above skin surface. The containers (1 mm Pt) are placed in a zinc case (1 mm Zn) which is fixed to the body with the aid of sponge rubber washers so that the centres of the containers lie 2 cm from the surface of the skin.

Maximum intensity at skin surface ..... 55 r/hour.
» » 4 mm below surface ... 37.5 r/hour.

Time of application as above ... 100 hours.

Nr. V. Moulage. On practically flat plats of a mixture of paraffin, beeswax and sawdust blocks 1 cm thick and measuring 2 × 3 cm are fused into contact. Into these blocks are fused radium containers with 10 mg of radium (1 mm Pt) each. The centres of the containers are about 8 cm apart, and are at an average distance of 2 cm from the skin surface. In the special case of the use of five 10-mg containers, one container is at the centre of a square, the others being at the corners, in which case:

Maximum intensity at skin surface ..... 23 r/hour.
» » » 4 mm depth ..... 17 r/hour.

Time of application as above ... 215 hours.

[1] For this case are the medical experiences, *i. e.* the mean time of application, derived from experiences with many applicators composed of 2—8 containers. The approximate intensities are calculated for a supposed »mean applicator» with 5 radium containers.

Nr. VI. 40 mg radium 4 cm above skin surface. The same zinc cases as in Nr. IV. are fixed with the aid of an aluminium stand so that the centres of the containers lie 4 cm above the skin surface.

Maximum intensity at skin surface ..... 17 r/hour.
» » » 4 mm depth ..... 13.7 r/hour.
Time of application as above ... 215 hours.

Nr. VII. Mesothorium/Radium Mass Unit. The total content is equivalent to 3.054 mg of radium. Fifteen tubes containing an average of 180 mg of radium gamma equivalent are arranged in a circle of radius 2.45 cm. The ratio of Ra : RaTh : MsTh2 is about 1 : 1 : 1. In the centre of the circle is a larger tube with a gamma-equivalent of 333 mg radium containing chiefly radium. The centres of the tubes are 8 cm distant from the skin. The field is circular of 2.6 cm radius. (A detailed description of the construction and measurement of this bomb will be published.)

Maximum intensity at skin surface ..... 360 r/hour.
» » » 4 mm depth ..... 330 r/hour.
Time of application as above ... 8.9 hours.

Times of Application.

The author desires here to express his grateful thanks to the medical staff of the Radiotherapeutical Institute, especially to the Chief Physician, Dr. M. Fořt, his Deputy Dr., Zd. Hlasivec, and to Dr. R. Rubeš for very kindly supplying actual recorded figures for these times. Their quite independent figures given for the average application times as found by practical experiment for the individual types of applicator differ but little among themselves, and their average has been used for calculation purposes. In spite of the considerable differences which may occur in individual cases, their figures mutually agree, so that the probable error from the mean is not more than 25 %.

In the succeeding table the application times are given for given doses at the skin surface and at 4 mm depth for the applicators described above.

Table III.

Applicator Nr.	Mean time of application hours	F. S. D. cm	r received during the application time: surface	4 mm depth
I.	45	0.25	18,000	3,800
II.	30	(0.25)	13,800	4,200
III.	45	(0.85)	6,000	3,200
IV.	100	2	5,500	3,700
V.	215	2	5,000	3,700
VI.	215	4	3,700	3,000
VII.	8.9	8	3,200	3,000

The average value of dose at 4 mm below the surface is thus:

$$3{,}500 \pm \text{cca } 600 \text{ r } (i.\ e. \pm 20\ \%)$$

whereas the surface dose varies between 3,200 and 18,000 r, *i. e.* by over 500 %.

It is interesting to compare these results with those obtained by experience with roentgen rays. Here we have to take into account the effects of the field size and also the time factor, *i. e.* the length of time required for the skin to obatin a given dose. The effects of these factors have been long known, and carefully studied *e. g.* by M. STRANDQVIST (6) and also F. ELLIS (7). From their graphs and tables we find that for roentgen treatment the biological reaction defined above corresponds after due comparison of fields and times[1] to a dosage of 3,000 to 3,500 r. (In roentgen work the intensity gradient is negligible, owing to the large F. S. D.) This numerical agreement is notable, but owing to the inaccuracy of the figures, it does not exclude a somewhat different biological efficiency of these two kinds of radiation.

In consequence of the importance of the intensity of radiation 4 mm below the surface of the skin we should in radium surface therapy base our application times on the measurement of this intensity. The centre of our (sufficiently small) ionisation chamber should therefore be placed in the required distance. In practice a chamber with an external diameter of 7—8 mm might be suitable and give for all types of surface applicators convenient dosage figures independent on the F. S. D.

SUMMARY

The surface dosage of gamma-rays required to produce a certain degree of skin reaction by radium therapy depends on the distance between the radiophore and the surface of the skin. At small F. S. D. we may apply even five times greater surface doses than at great distances.

On the basis of empirically determined application times convenient for the applicators used in the State Radiotherapeutical Institute, Praha-Bulovka, and of graphs showing the dependence of the intensity of radiation on distance, worked out for the applicators used, it could be demonstrated that the depth dose 4 mm below the surface is responsible for the reaction of the skin. In all cases, from F. S. D. 0.25 to 8 cm, the same degree of reaction (*i. e.* between epidermitis sicca and epidermitis exsudativa) is obtained if the dose 4 mm below the surface is 3,500 $\pm$ 600 r. Dosage figures obtained with ionisation chambers of an external diameter of 7—8 mm would be convenient for all types of surface applicators.

ZUSAMMENFASSUNG

Bei der Radiumtherapie ist die zur Hervorrufung eines bestimmten Grades der Hautreaktion notwendige Oberflächendosis der Gamma-Strahlen vom Abstande der Radiophoren von der Haut abhängig. Bei kleinen Entfernungen kann man eine bis-

[1] About one week.

fünffach grössere Dosis anwenden als bei grösseren Abständen. Auf Grund von empirisch gefundenen Applikationsdauern für die im Staatlichen Radiotherapeutischen Institut in Prag benützten Applikatoren und auf Grund von Kurven, welche die Abhängigkeit der Strahlungsintensität der benützten Radiophoren von der Entfernung angeben, wurde gefunden, dass die Reaktion der Haut durch die etwa 4 mm unter der Oberfläche der Haut gemessene Dosis gegeben ist. Der gleiche biologische Effekt (d. i. ein Zustand zwischen Epidermitis sicca und Epidermitis exsudativa) wurde stets mit einer Dosis von 3,500 $\pm$ 600 r in der Tiefe von 4 mm unter der Haut erzielt, obwohl die Entfernung der Radiophoren von der Haut in den Grenzen zwischen 0.25—8 cm bei den untersuchten Applikatoren verschieden war. Die mit Ionisationskammern von einem äusseren Durchmesser von 7—8 mm gemessene Strahlungsintensität würde also eine richtige Grundlage für die Dosierung geben.

RÉSUMÉ

En cas des applications du radium la dose superficielle des rayons gamma nécessaire pour produire une réaction biologique bien définie de la peau dépend de la distance du radium à la surface de la peau. Pour les petites distances on peut administrer des doses superficielles jusqu'à 5 fois plus grandes que celles appliquées à des distances plus considérables.

En se basant sur les données empiriques pour les temps d'irradiation avec les applicateurs employés dans l'Institut Radiothérapeutique d'État à Praha et à l'aide de courbes montrant l'intensité du rayonnement à différentes distances foyer-peau, on a trouvé que la réaction cutanée est déterminée par la dose mesurée à environ 4 mm au-dessous de la surface de la peau. Pour toutes les distances comprises entre 0.25 et 8 cm, la même réaction biologique (l'état intermédiaire entre l'épidermite sèche et l'épidermite exsudative) a été atteinte pour une dose de 3,500 $\pm$ 600 r à une profondeur de 4 mm au-dessous de la surface de la peau. On peut donc prendre comme base de dosage pour les applicateurs superficiels l'intensité du rayonnement mesurée avec une chambre d'ionisation dont le diamètre extérieur est de 7 à 8 mm.

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FROM THE ROENTGEN DEPARTMENT (CHIEF: E. LINDGREN, M. D.) OF THE SERAPHIMER HOSPITAL, STOCKHOLM, SWEDEN

ANGIOGRAPHIC STUDIES OF THE CEREBRAL VESSELS IN ARTERIOVENOUS ANEURYSMS[1]

by

R. Bunner

In the arteriovenous aneurysm the communication between the arterial and the venous systems consists either of a few main vessels or of a larger or smaller convolute of vessels. One or more dilated and tortuous arteries lead to the aneurysm. Owing to the direct communication between the arterial and venous systems, the draining veins will be subjected to considerably increased pressure. Hereby, they become extremely dilated and twisted.

By degrees the feeding arteries may undergo degenerative changes. The walls become thin and dilated, the muscle layer atrophies and the elastic coat decreases. Dilatation of the feeding arteries was already observed by WILLIAM HUNTER, who, in 1757, gave the first description of an arteriovenous aneurysm. BROCA, in 1863, described a case of arteriovenous fistula in the brachial artery, in which the artery proximal to the fistula had a circumference of 80 mm., the wall being very thin, scarcely 1/2 mm. thick. Later the changes in the feeding arteries to arteriovenous aneurysms and fistulas were carefully studied and investigated by HALSTEDT, CALLANDER, HOLMAN, REID and others. HALSTEDT collected 447 cases of pathological communications between arteries and veins, and of these he found 57 cases with dilatation of the artery proximal to the communication. CUSHING-BAILEY in their cases of cerebral arteriovenous aneurysm found hypertrophy of the internal carotid artery on the same side. Whether this was a question of a true hypertrophy or only a dilatation of the vessels does not appear with certainty from the text. YATES and PAINE, HERZOG, DANDY and others have also found dilatation of the feeding arteries by cerebral arteriovenous aneurysm. According to TÖNNIS, the internal and common carotid arteries are almost always found at arteriography to be respectively wider on the side of the aneurysm than on the opposite side.

[1] Submitted for publication, March 9, 1949.

The changes in the feeding arteries, according to REID, are due to several contributory factors. The pathological communications between arteries and veins replace the capillary net. The greater portion of the blood will pass through the wide communications between the arterial and venous systems as the resistance here is less than that of the normal capillary net. It becomes, thus, an increased quantity of blood that passes through the feeding arteries and, in order to be able to receive this increased blood quantity, the feeding arteries must be dilated. It is, however, continues REID, peculiar that this increased work for the feeding arteries does not lead to a hypertrophy and a strengthening of their walls. Instead, thin-walled vessels with degenerative changes are often found. Thus, some further factor must be found that gives rise to the degenerative changes. According to THOMA, a normal pulse pressure is necessary for the continuance of the integrity of the artery walls. NEY and others have shown that the pulse pressure in the feeding arteries to an arteriovenous fistula is obviously decreased, which might be the cause of the degenerative changes.

The cerebral arteriovenous aneurysm is diagnosed with certainty only through angiography. As result of the decreased peripheral resistance in the aneurysm, the blood stream and thus, also the injected contrast medium, to a large extent, will pass through the aneurysm, while the rest of the branches of the cerebral vessels will be more or less incompletely filled.

A large number of arteriovenous aneurysms, about 75, have hitherto been established by cerebral angiography in the roentgen department of the Serafimer Hospital. During later years, examination has also been made after extirpation of the aneurysm. This has been done in 16 cases, and in two of these, on two different occasions. In general the examination took place from two weeks to one year after the operation, but in one case, a good four years after operation. The purpose has been both to see if the extirpation of the aneurysms had been radical and also in order to study circulation changes that might have arisen in the arteries.

(All operations were carried out at Serafimer Hospital's neurosurgical clinic either by Professor H. OLIVECRONA or by G. NORLÉN, M. D.)

The dilatation of the feeding vessels is obvious in the case of large aneurysms, while sometimes in the case of small aneurysms it may be difficult to visualize. The degree of dilatation varies within relatively large limits. In a normal artery the width of the lumen diminishes relatively evenly in the direction of the blood stream. Such is not the condition in the feeding vessels in arteriovenous aneurysms, in which the width of the lumen is approximately the same from the beginning to the end of the dilatation. The dilatation of the feeding vessels usually extends in retrograde direction to the carotid siphon. If this and the more proximal

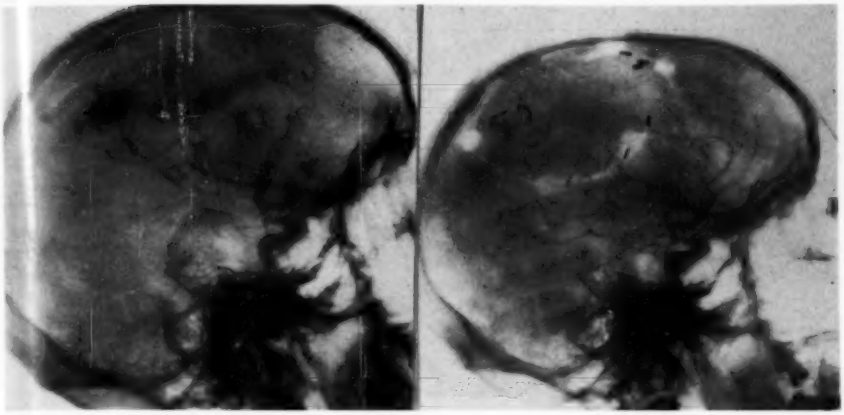

Fig. 1 a. Fig. 1 b.

Fig. 1 a. Walnut-sized arteriovenous aneurysm directly above the posterior portion of the Sylvian fissure. The feeding vessels are two branches from the Sylvian group, of which one is extremely dilated and tortuous, the other but slightly dilated. The carotis siphon is slightly dilated. Dilated draining vein to superior longitudinal sinus. No filling of anterior cerebral artery with contrast medium.

Fig. 1 b. Same case, 6 1/2 months, after operation. The aneurysm is radically removed. The dilatation of the carotid siphon has regressed. The dilatation of the feeding vessels has completely regressed and they have now normal width. The anterior cerebral artery is now well filled with contrast medium.

vessels also are dilated is generally extremely difficult to decide, and, as a rule, it is only through comparison between the width of the vessels before and after extirpation of the aneurysms that such a slight dilatation has been possible to demonstrate. Such a comparison shows that in 6 of the 16 cases a slight dilatation of the carotid siphon, and in two cases also a slight dilatation of the cephalic portion of the internal carotid artery was present.

It is postoperatively found in all cases that the dilatation of the feeding arteries has diminished noticeably or has completely regressed. Diminution of the dilatation in the feeding vessels and return to more normal width after operation has been established and described many times previously in cases of arteriovenous fistulas and aneurysms elsewhere in the body, but it has not previously been described in cases of cerebral arteriovenous aneurysm, as far as the author could ascertain in going through the literature, with the exception of one case which was demonstrated by G. NORLÉN at the meeting of the Northern Neurosurgical Association in Sept., 1946. Of 8 cases that were examined within two weeks

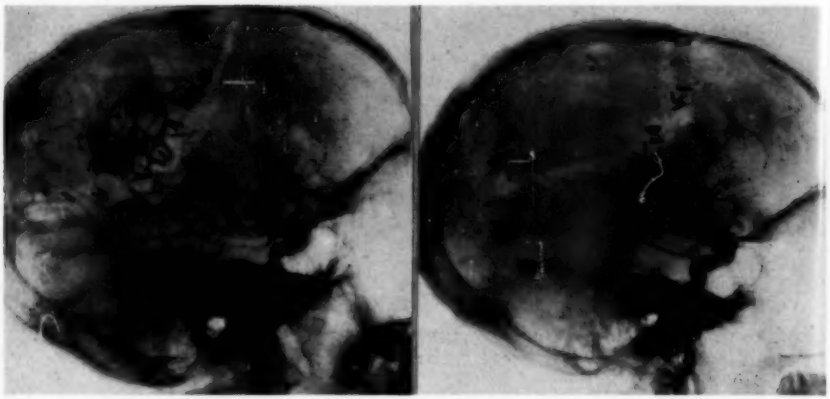

Fig. 2 a. Fig. 2 b.

Fig. 2 a. Large arteriovenous aneurysm in the posterior portion of the parietal region with dilated and tortuous feeding vessels coming from the middle cerebral artery. The dilatation extends proximal to the carotid siphon. The aneurysm empties into an almost walnut-sized sac situated cranial to the aneurysm, which in turn empties into the superior longitudinal sinus. No certain filling of the anterior cerebral artery with contrast medium.

Fig. 2 b. Same case, a good four years after extirpation of the aneurysm. The aneurysm has been completely removed. The branches from the middle cerebral artery that were dilated before operation are now of normal width. The anterior cerebral artery is slightly filled with contrast medium.

after the operation, no remaining dilatation of the feeding vessels was found in 7. In one case the feeding vessels were still somewhat distended on examination two weeks after operation but after another one year no dilated or otherwise pathological vessels were found. Of the remaining 8 cases, which were controlled more than two weeks after operation, no dilatation of the feeding vessels was found in five cases. One of the remaining cases had an aneurysm in the parietal region, whose feeding branches both came from vessels of the Sylvian group and also were formed of the anterior cerebral artery. Three weeks after extirpation of the aneurysm, the vessels of the Sylvian group had recovered normal width with the exception of some of them that still were somewhat dilated. The dilatation of the anterior cerebral artery remained approximately unchanged from the carotid siphon and at least half-way to the location of the removed aneurysm, where the vessel rapidly narrowed down to normal width. Remains of the aneurysm were found in two cases. The dilatation of the feeding vessels in these cases had diminished, but not completely disappeared.

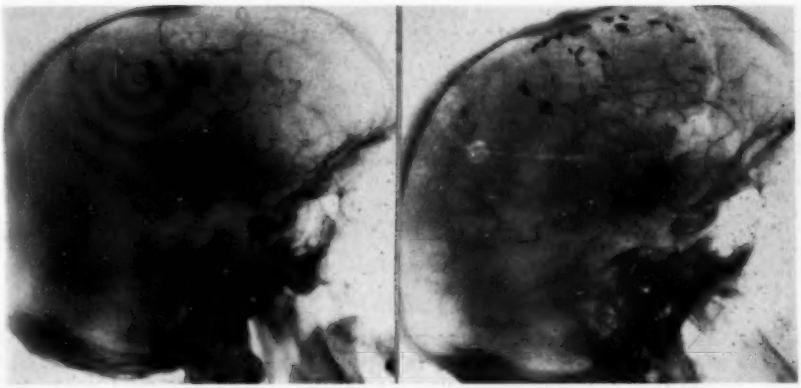

Fig. 3 a. Fig. 3 b.

Fig. 3 a. Arteriovenous aneurysm the size of a large walnut in the anterior portion of the parietal region. The feeding vessels are, for the most part, dilated and tortuous branches from the anterior cerebral artery but also, at least one dilated vessel comes from the middle cerebral artery. Dilated draining veins lead to the superior longitudinal sinus and downward to the Sylvian fissure.

Fig. 3 b. Same case, 10 days after operation. The aneurysm has been radically removed. The dilatation of the feeding arteries has completely regressed. No dilated veins. The distribution of contrast medium in the branches of the internal artery is more even now than before operation.

In four cases preoperative angiography had been done in the right as well as the left carotid artery. On comparison of the width of the internal carotid artery (including the siphon) before and after operation, dilatation could not be demonstrated in either of these cases. In three of the cases the carotid siphon had the same width on both sides. In the fourth case, in which the aneurysm was sited on the right side although partly supplied from the left, the left carotid siphon was slightly more dilated than the right. In the cases that were not examined until one month or more after operation and in which the operation had been radical, the feeding vessels had regressed to normal width. The rest of the vessels, that before operation were often more or less incompletely filled, were now, in general, well filled with contrast medium.

It appears from this series that the dilatation of the feeding vessels to arteriovenous cerebral aneurysms has already regressed in most cases, two weeks after extirpation of the aneurysm and that the vessels have resumed a normal roentgenological appearance. This seems to indicate that the dilatation is secondary to the aneurysm. No changes that might indicate pathological changes in the walls have been observed.

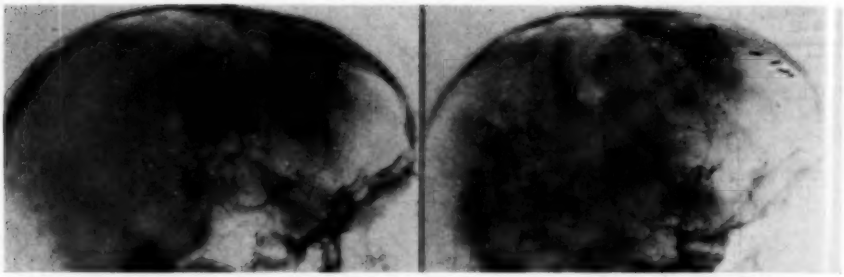

Fig. 4 a. Fig. 4 b.

Fig. 4 a. Plum-sized arteriovenous aneurysm above the middle portion of the Sylvian fissure with dilated feeding vessels from the middle cerebral artery. The dilatation of the feeding vessels extends to and includes the carotid siphon, which is somewhat dilated. A dilated draining vein leads posterior-inferior and a number of smaller veins lead upward to the superior longitudinal sinus.

Fig. 4 b. Same case, ten days after operation. The aneurysm has been completely removed. Neither arteries nor veins are dilated. The carotid siphon now has normal width and is narrower than before operation. Contrast medium is more evenly distributed in the vessels.

It has long been known that arteriovenous fistulas may result in enlargement of the heart. LERICHE, HOLMAN and others have described such cases and have been able to establish a diminution of the heart volume after the closure of the fistula. REID has been able to show experimentally on dogs that a fistula between the carotid artery and the external jugular vein may produce a hypertrophy and dilatation of the heart. In cases of arteriovenous fistulas situated in the periphery resulting in cardiac hypertrophy that developed slowly, REID found, at the same time, a dilatation of the feeding artery and, in a number of cases, this dilatation could extend all the way back to the heart. In cases without this dilatation of the feeding artery no enlargement of the heart could be demonstrated. REID has also found that congenital arteriovenous vessel communications do not give rise to any enlargement of the heart even if the feeding arteries are dilated, and considers that this depends upon the heart's having had time in these cases to accomodate itself to the changed conditions of the circulation. LINDGREN in three cases of arteriovenous aneurysm in the lungs has not been able to find any cardiac enlargement. Among the about 75 cerebral arteriovenous aneurysms demonstrated in the roentgen department at the Serafimer Hospital, roentgen examination of the heart was carried out in only a few cases. In one of the cases the total volume of the heart was 850 cc., corresponding to 460 cc. per meter^2 body surface. This patient, who had no subjective heart trouble, had had

a rheumatic infection 15 years earlier and clinically, signs were found of a heart failure. In the rest of the cases no enlargement of the heart could be established. Although these few cases are insufficient to permit any definite conclusions, they do confirm, however, the observations made earlier by HOLMAN, REID, LINDGREN and others, that congenital arteriovenous aneurysm does not lead to any cardiac enlargement. Also, the fact that dilatation of the feeding vessels does not extend farther centrally than along the upper portion of the internal carotid artery makes it probable, that no enlargement of the heart should arise.

SUMMARY

In arteriovenous aneurysms, dilatation of the feeding arteries can be arteriographically demonstrated in the majority of cases. With arteriography in 16 cases after extirpation of the aneurysm, it appears that, in general, this dilatation has already regressed two weeks after operation and that the rest of the cerebral vessels, which, before operation were slightly or not at all filled by contrast medium, are well filled after operation.

ZUSAMMENFASSUNG

Bei arteriovenösen Aneurysmen liegt in der Mehrzahl der Fälle eine arteriographisch nachweisbare Erweiterung der zuführenden Arterien vor. Bei Arteriographie an 16 Fällen nach Entfernen des Aneurysmas stellt sich heraus, dass diese Erweiterung im allgemeinen bereits vierzehn Tage nach der Operation zurückgegangen ist, und dass die übrigen Gehirngefässe, die vor der Operation nur schwache oder gar keine Kontrastfüllung aufwiesen, sich nach der Operation gut füllten.

RÉSUMÉ

Dans la plupart des anévrysmes artério-veineux il existe une dilatation des artères afférentes, démontrable par l'artériographie. En pratiquant des artériographies dans 16 cas après l'extirpation de l'anévrysme on a vu que cette dilatation avait rétrocédé en général déjà deux semaines après l'opération, et que les autres vaisseaux cérébraux, peu ou pas du tout remplis de substance de contraste avant l'intervention, en étaient bien remplis après celle-ci.

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FROM THE NEURO-ROENTGEN-DIAGNOSTIC LABORATORY OF THE UNIVERSITY CLINICS, LUND, SWEDEN (HEAD: OLLE OLSSON, M. D.)

INSTRUMENT FOR ENSURING SYMMETRIC PICTURES IN ROENTGEN EXAMINATIONS OF THE HEAD[1]

by

Olle Olsson

In the radiographic examination of the cranium it is essential that the patient's head be in a symmetric position. This applies not only to plain radiograms but also to most kinds of radiographic examinations of the cranium and its contents: encephalography, ventriculography, carotid angiography, vertebral angiography, and cranial tomography.

An asymmetric position of the head may render the examination more difficult and is even liable to lead to serious misjudgements.

Special instruments have been constructed to facilitate a correct position of the head for craniographic examinations. The most well-known apparatus for this purpose is LYSHOLM's skull-table. But despite such good technical equipment it is sometimes difficult even for skilled personnel to produce symmetric pictures. Less experienced examiners — all those engaged in the radiologic departments without daily routine craniologic examinations — often find it difficult to produce satisfactory pictures.

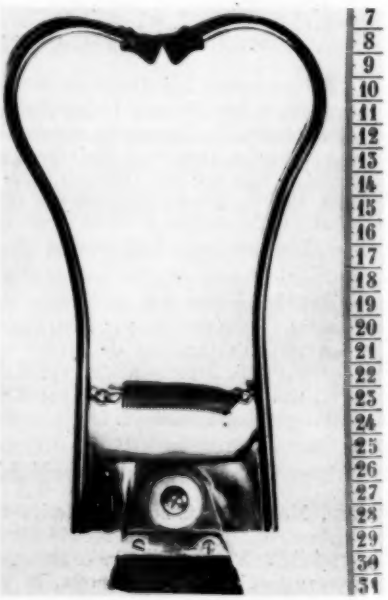

Fig. 1. The instrument. In the cross-plate at the fixing-point between the two branches a little water level is mounted.

With a view to help these examiners, the author has designed a simple instrument with which the

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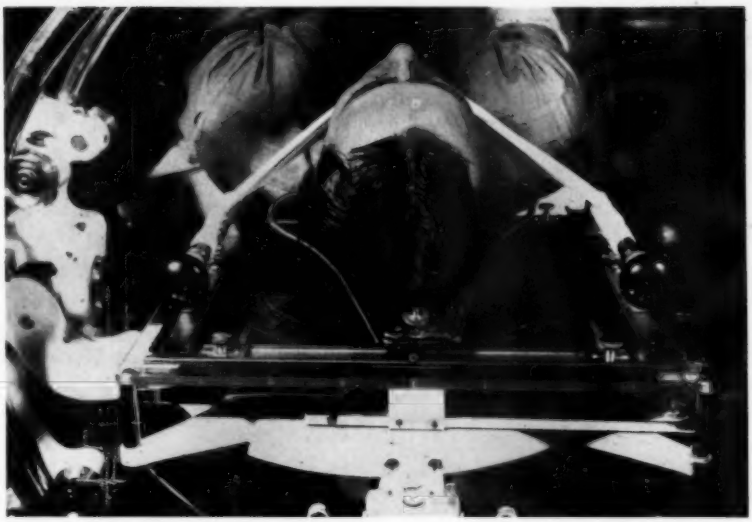


Fig. 2. The instrument in position.

position of the head may be easily adjusted with the degree of accuracy necessary for good symmetric radiograms of the cranium.

Construction: The instrument consists of two metal branches. An earpiece of the same type as used for binaural stethoscopes is attached to the free end of each branch, whose other end is fixed to a cross-plate on which is mounted a small water level. When the instrument is in position the cross-plate with the water level can swing in one plane only (Fig. 1).

Use: The branches are placed in position on the patient with the earpieces in his external auditory canals. The patient's head is then placed into more or less correct position, where it is held by the restraining bands of the skull-table. Without touching the patient's head the examiner then tightens the band on one side or the other until the air bubble is midway in the length of the level (Fig. 2).

In most cases it is not necessary to remove the instrument until after exposure.

Occasionally, a cranial asymmetry exists with the external auditory canals located at different levels. In those cases the apparatus cannot be used. Such asymmetry is, however, generally easy to detect if the head is viewed from above. These cases cannot at all satisfy the fundamental requirements for symmetric pictures.

The instrument has been used a long time at the Roentgen-Diagnostic Department of the University of Lund, especially at the Neuro-Roentgen Diagnostic Laboratory. It has proved easy to handle and useful in those kinds of cranial examinations generally performed at such a laboratory.

SUMMARY

Description of a simple instrument with an ordinary water level to secure symmetrical position of the head in craniological examinations of several kinds.

ZUSAMMENFASSUNG

Beschreibung eines einfachen Instruments mit einer gewöhnlichen Wasserwage zur Sicherung einer symmetrischen Lage des Kopfes bei kraniologischen Untersuchungen verschiedener Art.

RÉSUMÉ

Description d'un instrument simple, avec un niveau d'eau ordinaire, qui assure une position symétrique de la tête dans divers examens craniologiques.

FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (CHIEF: PROFESSOR ÅKE ÅKERLUND) OF THE KAROLINSKA SJUKHUSET, STOCKHOLM, SWEDEN.

THE FETAL RENAL SECRETION AND ITS SIGNIFICANCE IN CONGENITAL DEFORMITIES OF THE URETERS AND URETHRA[1]

by

Sven Roland Kjellberg and *Ulf Rudhe*

In an article on the diagnosis of congenital posterior urethral valves which was published in Acta Radiologica in 1948, the authors, JORUP and KJELLBERG, point out, amongst other things, the necessity of treating cases of these deformities as early as possible after birth. As a matter of fact the secondary changes in the urinary passages can be so extensive in a few weeks post partum that, despite an early diagnosis, therapy is useless and the child dies. Such were the circumstances in the author's case No. 1. There were good reasons for supposing that the dilatation of the urinary passages actually occurred during intrauterine development. The valves in the posterior urethra formed an obstruction to the flow of the fetally secreted urine causing a rise in prestenotic pressure as a result. Cases, with so highly a pronounced dilatation of the urinary passages and an abdominal volume of such a dimension that it is impossible to deliver the embryo, are known from the literature and a case of this nature was recently described by THIERSTEIN, COLEMAN & TANNER.

The simple mechanical explanation for the dilatation of the urinary passages in this case as well as in cases having similar deformities in the ureters are, however, not generally accepted. Amongst others, KERMAUNER has asserted that even the dilatation itself is a developmental malformation. Therefore the dilatation should not be directly caused by a rise in prestenotic pressure.

The conception of the significance of rise in pressure naturally depends on whether it is possible to establish the presence of secretion and flow of urine during embryonic life.

[1] Submitted for publication, March 8, 1949.

With regard to the secretion from the kidneys of embryos, TAUSCH (1936), in a comprehensive review, mainly of German investigations, has established beyond all doubt that, from and including *the latter half of pregnancy*, the kidneys of the embryo are not only capable of functioning but that they also secrete. He supports his statement regarding this primarily on the investigations of GUTHMANN & MAY (1930, 1932). Amongst other things, these authors have determined the freezing point and concentration of urea and uric acid in human amniotic fluid from and including the middle of the second month up to and including the tenth embryonic month. They found that the urea and the uric acid content increased as pregnancy progressed and that the amniotic fluid became simultaneously more and more hypotonic. The concentration of urea and uric acid in the blood of the mother was constant within the limits of the physiological variations.

It would seem that only a few investigations concerning the presence of secretion from the embryonic kidney during the first half period of pregnancy have been published.

Thus, in 1931 MAKEPEACE and others, also found the freezing point of the amniotic fluid became progressively higher as pregnancy progressed. It was only during the very earliest embryonic months that the amniotic fluid was isotonic in relation to the mother's serum. The bladder urine of a fetus of the 6th and 9th fetal month was markedly hypotonic ($D = 0.°141$—$0.°174$). In a case of a 3—4 months' pregnancy, a few drops of urine were obtained by light pressure on the abdomen of the fetus. The authors came to the conclusion as a result of their investigations that the amniotic fluid is originally a dialysate in equilibrium with the body fluids of the mother and the fetus. As pregnancy proceeds further, a dilution of the amniotic fluid takes place through being mixed with hypotonic fetal urine.

In 1938 CAMERON & CHAMBERS prepared a tissue culture of segments of the uriniferous tubules taken from a $3^1/_2$-month-old human embryo and were able to show histochemical properties of such a character as to suggest the possibility of secretion.

A number of experiments carried out on animals and published by WOLF, WATSON as well as PATON, WATSON & KERR, have shown analogous conditions. The opinions of these authors have been further emphasized by NEEDHAM in his monograph: »Chemical Embryology».

It has not been definitely established to what extent a continued mixing of transudate from the mother and/or possibly secretion from the amniotic epithelium takes place with the amniotic fluid. Neither has one been able to arrive at any definite conclusion as to what extent a reabsorption of fluid takes place through the vessels of the urinary bladder or the allantois, nor to what extent the amount is regulated by

the fact that the embryo swallows amniotic fluid. These questions, however, have no definite significance as far as this investigation is concerned.

As far as we know, there has been nothing previously published about the use of radiopaque medium for the examination of the renal secretion in a fetus.

When BARCLAY in 1942 carried out his investigations for the study of the fetal circulation he found that a 35 % solution of Perabrodil (Diodrast) was well tolerated by experimental animals (sheep, rabbits).

A contrast medium of the Perabrodil type has the additional advantage that its presence can be determined comparatively easily even in small non radiopaque amounts, in for instance, urine or amniotic fluid, by a chemical determination of the iodine content. We have considered that it would be interesting to demonstrate the supposed secretion of the kidney under intrauterine conditions by injecting this contrast medium (Dijodon, Leo) into the umbilical cord of embryos.

Technique

The investigations were carried out partly on human embryos and partly on the embryos of rabbits. The experiments which were carried out on human embryos were done on cases during legal abortion.[1] These operations were Caesarean sections. The mothers were anesthetized with ether-nitrous oxide mixture. After incising the uterus and perforating the membranes, the umbilical cord was exposed. The residual amount of amniotic fluid was sufficient to prevent the entrance of air into the respiratory passages of the fetus.

It has been of vital interest to preserve, as far as possible, the physiological intrauterine conditions with undisturbed circulation through the umbilical cord and placenta. Therefore the placenta was kept intact during the experiment. The contrast medium, the amount of which varied between 1—10 cc (35 % Dijodon, Leo), was carefully injected into the umbilical vein in 4—5 minutes. After a lapse of another 7—10 minutes, the fetus was removed from the uterus and the umbilical cord severed. A series of urograms of the fetus were taken during the next 20 minutes in cases 1—6. In one case of three months' fetus it was not possible to make a venal puncture because of the minute calibre of the umbilical cord, and in yet some other cases one had to refrain from making the examination because the placenta was directly beneath the uterine incision.

[1] We beg to tender our thanks to all our colleagues in the obstetrical and gynecological clinic of the Karolinska sjukhuset for their great courtesy and invaluable help in connection with the procedure.

Results

Table

Cases nr.	Length of the fetus cm	Age (months)	Iodine content of fetal urine mg %	Iodine content of mother's urine mg %	Contrast shadow in the bladder immediately after ligation of the cord.	Contrast shadow in the bladder after about 10 min.	Injected amount of 35 % Dijodon cc	Urine volume cc
1	26	V—VI			—	+	1—2	
2	30	VI			—	+		
3	15	IV			—	+ ?		
4	24	V			—	+		
5	30.5	VI—VII	405	52	+		10	8
6	26	V—VI	170	412	+		5	4
7	22	V	132	49			3	2
8	23	V	10	22			1	2

In the first four cases, where only 1—2 cc contrast medium was injected, no contrast medium could be seen in the urinary tract on the radiographs which were taken immediately after the severing of the umbilical cord. In all probability, however, an intrauterine kidney secretion had taken place, at least in the first two cases. A part of the contrast medium is withdrawn from the renal circulation of the fetus, when it passes to the mother via the umbilical arteries and the placenta. The amount of contrast medium injected was therefore too small to give a visible secretion. No iodine determination was carried out. One found, however, that when the amount of contrast medium injected was increased to 5 and 10 cc, respectively, as was done with the following cases which were of correspondingly advanced fetal development as cases 1 and 2, one obtained an absolutely unmistakable contrastfilled shadow of the bladder (see figs. 1 & 2). On the other hand, there was no filling of the renal pelves and ureters with contrast medium. This is explained by the weak concentration of the contrast medium in the hypotonic urine.

In order to ensure that the secretion is not caused by a change in the fetal circulation due to the cutting of the umbilical cord but was rather an expression of intrauterine secretion, we have, in the last two cases (7 & 8) emptied the fetal bladder (by applying pressure on the fetal abdomen above the symphysis) directly after cutting the umbilical cord.

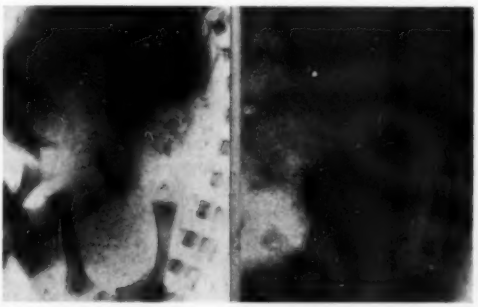
Even in these two cases one was able to establish by chemical means the presence of contrast medium in the fetal urine. *Therefore one could verify by means of these investigations, that a fetal renal secretion appeared as early as the fourth — fifth fetal month.*

Fig. 1. Fig. 2.

Is is also worth while pointing out that contrast medium could be demonstrated in the urine of the mothers in all cases where an iodine determination had been made. Thus, the placenta is permeable to contrast media of the Perabrodil group, at least in the direction of fetus—mother.

In accordance with the directives of the law concerning abortion we were only allowed to carry out our investigations on fetuses younger than 24 weeks.

In order to establish to what extent the fetal kidney's greater capacity to concentrate urine during the later part of pregnancy could contribute to the appearance of the renal pelves and the ureters on the radiograph, investigations were made on four embryonic rabbits of between 22 and 30 days old (the normal period of gestation of a rabbit is 30 days). The rabbits were anesthetized with urethane. The uterus was exposed and the uterine wall incised so that the umbilical cord could be seen. 0.2—0.5 cc 20 % Dijodon was injected through intact membranes. No amniotic fluid escaped. The placental attachment was not disturbed. The contrast medium could only be seen radiographically in the renal pelvis of the most developed embryo (30 days old). See fig. 3.



← Renal pelvis

← Extra ureteral contrast depot

Fig. 3. Fig. 4.

A retrograde pyelography was then carried out on the removed embryo in order to verify the roentgenological findings as will be seen fron fig. 4.

Discussion

By authors mentioned in the introduction, the presence of a fetal renal secretion has either been directly established by 1) noting the occurrence of urine in the fetal bladder in single cases, or 2) has been assumed through more extensive investigations by means of continuous physicochemical examinations of, primarily, the amniotic fluid.

Fetal renal secretion can also be shown radiographically after injecting contrast media of the Perabrodil type (Dijodon) into the umbilical vein. This was done, as far as possible, under undisturbed intrauterine conditions. In view of the insignificant stimulating effect of Dijodon, the extremely slow injection technique used, as well as the gentle anesthetic, it is probable that the secretion is not liberated by the various interventions but is an expression of an already existing intrauterine renal secretion.

The prestenotic dilatation of the urinary tract occurring in newly born children with congenital ureteral or urethral stenosis should therefore, to a preponderant extent at least, be ascribed to the successive rise in pressure which the continuous secretion of urine, that has been going on for several fetal months, must cause.

SUMMARY

Fetal renal secretion can be shown radiographically in human fetuses from and including the 4th—5th fetal month. It is possible to establish chemically the secretion of contrast medium of the Perabrodil type by determining the iodine content of fetal urine. The placenta is permeable to contrast medium of this type at least in the direction of fetus—mother. The prestenotic dilatation of the urinary tract occurring in newly born children with congenital ureteral or urethral stenosis should therefore, to a preponderant extent at least, be ascribed to the successive rise in pressure which the continuous secretion of urine, that has been going on for several months, must cause.

ZUSAMMENFASSUNG

Eine fetale Nierensekretion lässt sich am menschlichen Fetus vom 4.—5. Fetalmonat an röntgenologisch nachweisen. Die Kontrastausscheidung lässt sich durch Jodbestimmung am Fetalharn chemisch nachweisen. Die Plazenta ist wenigstens in der Richtung Fetus—Mutter für Kontrastmittel vom Typus des Per-Abrodil durchgängig. Die bereits bei Neugeborenen mit kongenitalen Urethra- oder Ureterstenosen auftretende prästenotische Harnwegserweiterung dürfte also, wenigstens grösstenteils, durch die allmähliche Drucksteigerung bedingt sein, die die ständige, mehrere Fetalmonate lang dauernde Harnsekretion erzeugen muss.

RÉSUMÉ

La sécrétion fœtale du rein peut être mise en évidence chez le fœtus humain par les Rayons de Roentgen à partir du 4:e ou 5:e mois de la grossesse inclusivement. L'excrétion de la substance de contraste est constatable chimiquement par la recherche de l'iode dans les urines du fœtus. Le placenta est perméable aux substances de contraste du type du Perabrodil, du moins dans la direction du fœtus vers la mère. La dilatation des voies urinaires, en amont de la sténose, qu'on trouve déjà chez les nouveaux-nés atteints de rétrécissements de l'urèthre ou de l'uretère, devrait donc, du moins en majeure partie, être conditionnée par l'augmentation progressive de la pression que doit entraîner la sécrétion urinaire se poursuivant de façon continue pendant plusieurs mois de la vie intrautérine.

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FROM THE ROENTGEN DIAGNOSTIC DEPARTMENT OF THE UNIVERSITY CLINICS IN LUND, SWEDEN (HEAD: PROFESSOR HANS HELLMER, M. D.)

HYALURONIDASE AS A FACTOR HASTENING THE SPREAD AND ABSORPTION OF WATER-SOLUBLE RADIOPAQUE SUBSTANCES DEPOSITED INTRACUTANEOUSLY, SUBCUTANEOUSLY OR INTRAMUSCULARLY[1]

by

Olle Olsson and *Olov Löfgren*

In 1936 MEYER, DUBOS and SMYTH described the lytic principle of pneumococcus on certain tissue polysaccharides, an enzyme since named hyaluronidase. The recognition of the enzyme constituted an important complementary link in the chain of observations started by DURAN-REYNALS (1929) in his research work on the effect of extracts from certain animal organs, especially of testes, on the infecting power of vaccine virus.

Hyaluronidase is widely distributed in animals and an essential activity is ascribed to it in various biological processes. It plays a fundamental rôle as a spreading factor (CHAIN & DUTHIE, HOBBY, SCHAFFE & DAWSON 1940, and others). An injection of hyaluronidase into the tissues will increase the permeability of connective tissue and thereby facilitate and hasten the spread and absorption of various substances, such as toxins, dyes, and saline (MCCLEAN, HOFFMAN & DURAN-REYNALS 1930, SANELLA 1940, SCHWARTZMANN, HENDERSON, KING 1948, and others).

It is only natural to test the suitability of hyaluronidase for various purposes in which a rapid absorption from the tissues of a rather large quantity of injected fluid is desired. This is the case, for example, with the subcutaneous or intramuscular injection of a water-soluble radiopaque substance in excretory urography.

In such examinations the contrast medium is as a rule given intravenously, but occasionally, especially in infants, venepuncture is troublesome or difficult and, in some cases, impossible. For this reason injection of the contrast medium subcutaneously or intramuscularly (BUTZENGEIGER 1931, HUNT & POPMA 1938) was proposed. The principle inherent

[1] Submitted for publication, March 21, 1949.

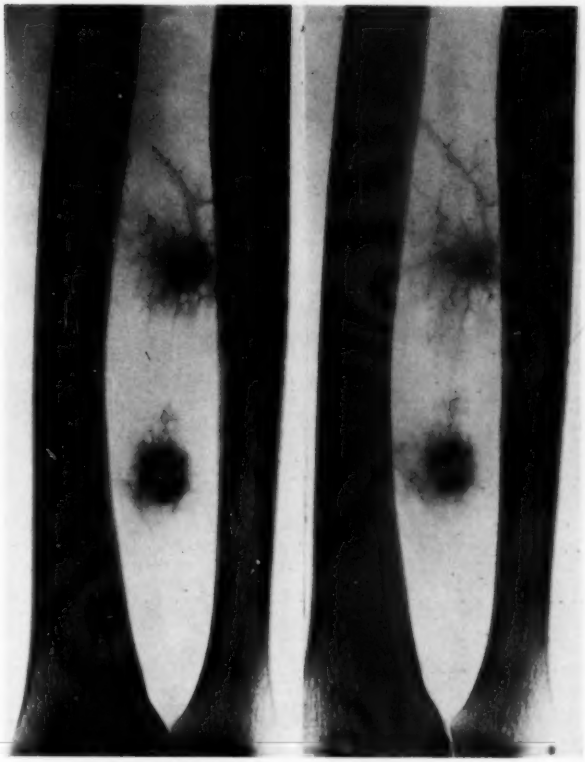

Fig. 1 a. Fig. 1 b.

Fig. 1. a. (10 minutes prior injection intracutaneously in the dorsal aspect of the forearm of 1 cc. saline and 4 centimeters more proximally injection of 1 cc. saline containing 1 TRU hyaluronidase.)

The picture shows the condition immediately after the injection of $^1/_2$ cc. contrast medium of diodrast type in 35 p. c. solution in the distal saline-swelling and in the proximal hyaluronidase swelling. A rapid spread of the radiopaque substance around the hyaluronidase swelling is observed.

Fig. 1 b. 2 minutes later the density of the hyaluronidase swelling has decreased considerably and the contrast medium has spread rather far along in irregular streaks corresponding to the lymphatics.

disadvantages in this injection technique was, however, the relatively slow absorption and the consequentially slow excretion of the preparation by the kidneys with the result that the density of the radiopaque urine in the renal pelvis was often insufficient for the production of

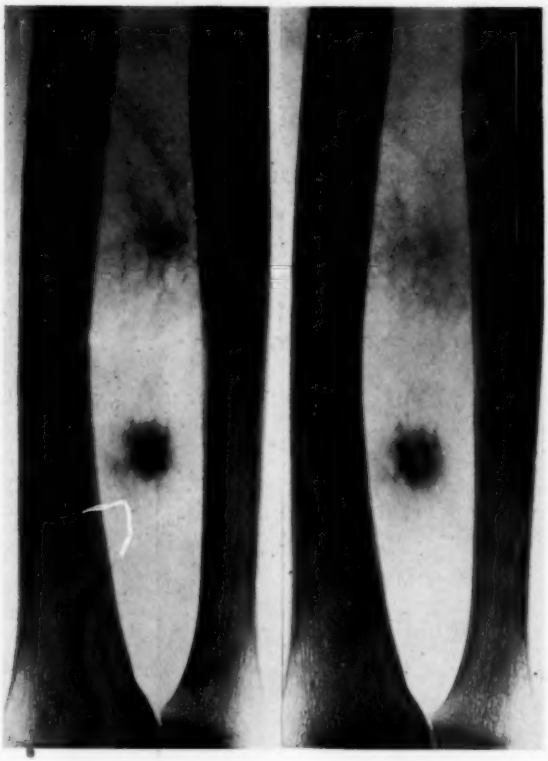

Fig. 1 c. Fig. 1 d.

Fig. 1 c and d. 5 resp. 10 minutes after the contrast injection. Radiopacity is persistent in the contrast saline-swelling whilst the density has practically disappeared from the proximal area pre-treated with hyaluronidase.

satisfactory urograms. Another objection was that the relatively low tolerance of the subcutaneous tissue to the preparation made it necessary to dilute the latter with large quantities of fluid, causing tension and tenderness over the injection site.

These disadvantages prompted WALLDÉN (1944) to administer the radiopaque substance into the bone marrow.

Hyaluronidase seemed to offer another approach to the problem. An investigation was started by the authors and the results will now be briefly reported.

In order to study the course and effect of the absorption of water-soluble radiopaque substances deposited intracutaneously and sub-

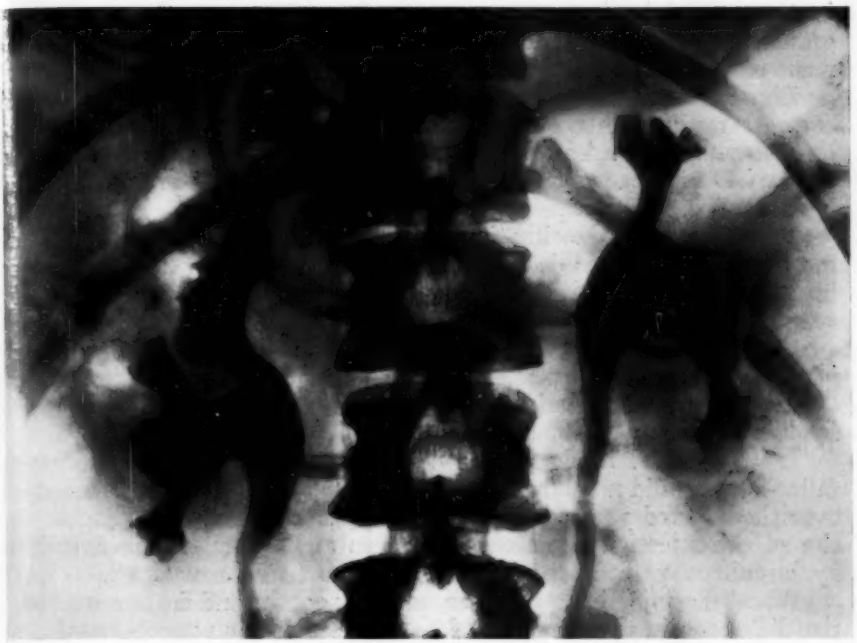

Fig. 2. Adult woman. Excretion urogram with compression of the ureters. The picture is obtained 30 minutes after subcutaneous and intramuscular injection of 13 cc. 35 p. c. diodrast (and 26 cc. ster. water) in the gluteal region 10 minutes previously injected with 2.5 TRU hyaluronidase.

cutaneously in areas previously injected with hyaluronidase preliminary tests were carried out on animals and then on ourselves and some colleagues at the Roentgen Dept. In man 1 cc. saline containing about 1 TRU hyaluronidase was injected intracutaneously or subcutaneously into the dorsal aspect of the forearm. A few centimetres distal of the injection 1 cc. saline only was deposited in the same manner.

Hyaluronidase is generally measured in TRU, turbidity reducing units. One TRU hyaluronidase is defined as the amount of enzyme per cc. which will reduce the turbidity given by 0.2 mg. hyaluronic acid to that given by 0.1 mg., in a specified system in which the hydrolysis is carried on for 30 minutes. The preparation at our disposal, Hyalas (Leo), is available in ampules of 2.5 TRU, corresponding to a quantity of 2—5 γ of the substance, which is dissolved in saline. Standardization of the preparation is, however, not exact and the preparation not yet completely purified.

Ten minutes later 0.5 cc. contrast medium of the diodrast type in 35 per cent solution was deposited intracutaneously or subcutaneously

in the same injection areas and the absorption controlled roentgenographically. A typical series of roentgenograms made in such an experiment is shown in Fig. 1.

Fig. 1 a shows the picture immediately after the injection of 0.5 cc. contrast medium in the distal saline-swelling and in the proximal hyaluronidase swelling. A rapid spread of the radiopaque substance around the hyaluronidase swelling was observed as soon as the preparation had been applied.

Fig. 1 b depicts the situation 2 minutes later. The density of the hyaluronidase swelling has decreased considerably and the contrast medium has spread rather far in irregular streaks corresponding topographically to the lymphatics.

Figs. 1 c and d show the stage reached 5 and 10 minutes after the injection. Radiopacity is persistent in the contrast saline-swelling, whilst the density has practically disappeared from the area pre-treated with hyaluronidase.

It was noticed in the course of the examination that the contrast-saline-swelling did not subside for rather a long time and that tenderness over the injected area persisted still longer, whereas the swelling at the site of the injection given subsequent to an intra-cutaneous deposit of hyaluronidase passed off rapidly leaving no tenderness at all.

When the injection was given subcutaneously and intramuscularly, the difference in the effect was less conspicuous. It was observed that certain macroscopic tissue elements, especially the blood vessels and the lymphatics, were clearly visualizable in the roentgenogram as contrast defects and contrast fillings in the injected areas.

The investigation thus showed that hyaluronidase hastens the absorption and spread of intracutaneous or subcutaneous contrast injections. This effect could be easily and beautifully demonstrated and controlled roentgenographically in man.

After these experiments, in which no undesirable attendant effect was recorded, we tested hyaluronidase in excretory urography.

The preparation was administered in the urologic examination of several patients, both infants and adults. It was found that treatment of the injection site, generally the gluteal region, with a subcutaneous and intramuscular deposit of 2.5 TRU hyaluronidase 10 minutes prior to the injection of the contrast medium, facilitated the injection and hastened the spread and absorption of the radiopaque substance. The infiltration of the tissues was slight and very transient. The resistance offered to the injection was remarkably low. The injection was not followed by a sense of tension or tenderness over the injected area. By injecting the contrast medium into both buttocks but pre-treating only one of them with hyaluronidase, it was possible by inspection, palpation, and roentgenologic

examination to study the absorption. These examinations showed that on the side pre-treated with hyaluronidase the contrast medium was absorbed much more rapidly, with the result that the subsequent swelling was of shorter duration, besides which the patient felt no pain, tenderness or sense of tension afterwards.

Fig. 2 shows a urogram of an adult, made with the subcutaneous and intramuscular deposit of a radiopaque substance in the gluteal region, in which 2.5 TRU hyaluronidase had been injected 10 minutes earlier. Only 13 cc. contrast medium (of the diodrast group in 35 p. c. solution) was injected, diluted with 26 cc. sterile aqua dest. Note optimal concentration of contrast urine in the renal pelvis within the usual time.

It should be observed that the initial radiopacity in the renal pelvis when the preparation is administered in this manner is but very slightly later than when administered intravenously. As a rule contrast excretion can be recorded already 3 mins. after administration.

The urograms made both in adults and infants were satisfactory and in every other respect comparable to those made with the intravenous injection of the contrast substance.

This investigation introduces the use of hyaluronidase into the clinical field of roentgen-diagnostics as a means to hasten and increase the spread and absorption of radiopaque substances deposited in the tissues. Its use in roentgen-diagnostics will surely be widened, especially in the roentgen examination of the soft parts. This is already predicted by preliminary results obtained in an investigation being carried out at present of its practicability in association with the diagnosis of expansive processes in the soft tissues and in lymphography (Olle Olsson, Ekman, Löfgren).[1]

SUMMARY

A roentgenological method is given for demonstrating and controlling the spreading and absorption-promoting effect of hyaluronidase in man, and the enzyme is introduced into the clinic for hastening the spread and absorption of water-soluble contrast media injected into the tissues.

ZUSAMMENFASSUNG

Es wird eine röntgenologische Methode vorgelegt zur Veranschaulichung und Kontrolle der verteilenden und absorptionsfördernden Wirkung von Hyaluronidase beim Menschen; und dieses Enzym wird in der Klinik eingeführt zur Beschleunigung der Verteilung und Absorption in die Gewebe eingespritzter, wasserlöslicher Kontrastmittel.

[1] At the end of the present investigation Simon & Narins published an article in Am. J. Roentgenol. vol. 61, p. 91, on the demonstration in guinea-pigs of the effect of hyaluronidase on the absorption of a subcutaneously deposited radiopaque substance. In this article they also suggest the possible use of hyaluronidase in subcutaneous excretory urography in infants.

RÉSUMÉ

Indication d'une méthode radiologique pour démontrer et contrôler, chez l'homme, l'action favorisante de l'hyaluronidase sur la dissémination et l'absorption. Introduction de l'enzyme dans l'usage clinique pour accélérer la dissémination et l'absorption de substances de contraste hydro-solubles injectées dans les tissus.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT OF THE CHILDREN'S HOSPITAL, GOTHENBURG, SWEDEN (HEAD: DR. C.-J. HANSSON)

DISTENSIONAL LUXATION, AN EARLY SYMPTOM SOMETIMES OCCURRING IN VARIOUS CONDITIONS OF PAIN IN THE HIP JOINT[1]

by

Jan-Carl Encrantz

When early roentgenological symptoms in coxalgias are analysed, changes are observed within the joint as well as outside it.

As early as the 1920's LAURELL emphasized the importance of observing possibly occurring periarthritic swelling in coxitis. The same attitude was adopted by others, *e. g.* DE LORIMIER in his book »The Arthropathies» (1943).

In his article »On the Infantile Coxitis and its Sequelae» (1937) S. CHR. IVERSEN states, that the earliest sign is a subluxation of caput outwards-upwards. Similar lines of thought can be traced in de Lorimier's book. He says more generally about infectious arthritis, that at an early stage this passes with »Joint space: Expanded». S. JORUP and S. R. KJELLBERG follow the same line in their article on acute septic osteomyelitis, periostitis and arthritis (1948), from which article the following is quoted: »If the change affects a joint, a distension of the soft tissues of the joint (the joint capsule), with possibly an increase in the amount of fluid in the joint, can often be noticed.» The word »distensional luxation» is a synthesis of Iversen's name on one side and Jorup's and Kjellberg's on the other. In various conditions of pain in the hip joints in children we have at the Children's Hospital of Gothenburg observed different degrees of distension in the joint. As there is no investigation to be found in the textbooks aiming at this special symptom, the account given below has been considered to be of some value.

During the years 1945—1948 there have been nursed in the surgical department at the Children's Hospital of Gothenburg 244 cases, in which the roentgenological examination of the hip joints and the clinical diagnosis filled the following fixed requirements:

[1] Submitted for publication, March 16, 1949.

Fig. 1. Morbus Perthes sin. Girl aged 3. Slightly expanded joint space on the left side.

1) It must be possible to observe both hip joints in the same frontal roentgen picture and in a comparatively symmetrical position.

2) Cases with the diagnoses Coxitis tuberculosa, Luxatio coxae congenita, and Morbus Perthes have been excluded.

When considering whether distensional luxation exists or not, we measured the distance between the two articular cortexes starting from a point closely below the Y-cartilage. The symptom has been considered to exist when the roentgen picture supported the opinion that there is an extension of the joint fissure, and when on measurement according to the above principle a difference of at least 2 mm is stated between the sound and the diseased side.

Several sources of errors are to be taken into consideration in the measurements. Increased values may be stated on account of asymmetry between the acetabuli and the caputs of the right and the left sides. If asymmetry exists, the difference between the two sides may be 2 mm. Early cases of Morbus Perthes (Fig. 1) afford another fallacy. LORIMIER writes about early symptoms in this disease: »Joint space: Possibly slightly expanded (due to misfit and possibly fluid).»

When increased distension of the hip joint exists, caput is at first displaced perpendicularly to the joint surface of the acetabulum. The result is a downward-outward movement. When the distensional luxation becomes more marked, the position described by IVERSEN (luxation outwards-upwards) sets in. The change of the direction is due to the fact that caput must first glide a little forward over the outward edge of the acetabulum. When this stage has been reached, tendons and muscles effect the subluxation outward-upwards.

For technical reasons the roentgen pictures do not in all cases allow of a reliable judgement of possibly existing periarthritical changes, so a detail account in this respect will not be given.

Occasional greater trauma or repeated less ones may in themselves give rise to changes in the form of distension of the joint. It is also conceivable that they pave the way for a subsequent infection by producing a locus minoris resistentiae (cf. the history of case 3, journ. No. 2843/47, in which the symptoms appeared in connection with sliding). In certain cases a low-virulent infection is likely to cause distensional luxation without SR and temperature being necessarily affected in any appreciable degree.

Table 1

	Total number of cases	Number of distensional luxation among them
A. Vague conditions of pain in the hip joint. These include the diagnoses Coxitis simplex, Hip observation and Observation of pains in the legs	138	11
B. Cases of infection. Comprise the diagnoses Coxitis septica and Osteomyelitis	11	8
C. Traumatically conditioned cases, *e. g.* Contusio and Fractura	50	—
D. Other cases. Pes planus, Scoliosis etc.	43	—

All the cases belonging to the infection group were submitted to chemotherapy.

In 4 cases of distensional luxation trauma has been mentioned in the anamnesis. In the remaining 15 cases this is denied or has not been brought up for discussion.

Out of the 11 cases of distensional luxation belonging to the group »Vague conditions of pain in the hip joint» SR and temperature were normal in 9 cases. The remaining 2 cases, free from fever, showed rise of SR.

Table 2

Group A = Vague conditions of pain in the hip joint.
Group B = Cases of infection.

	Total number of cases		Number of cases of distensional luxation among them	
	Group A	Group B	Group A	Group B
Boys	93	7	7	5
Girls	45	4	4	3
Right side	65	4	10	1
Left side	73	7	1	7
Babies	3	4	—	4
Infants (aged 1—3)	44	2	3	2
Children (aged 4—6)	52	2	4	2
School children (aged 7—9)	22	—	4	—
School children (aged 10—15)	17	3	—	—

The boys outnumber the girls. This is probably due to the more cautious disposition of girls.

It has not been possible to discover any constant tendency to difference between the number of patients with symptoms in one side and the number of them with symptoms in the other hip.

The division between the groups of children in the ages of 7—9 and 10—15 is due to the fact that the oldest child with stated distensional luxation was 9 years of age. It may be presumed that in older children the possibility of displacement of caput is substantially diminished owing to their firmer joint capsules and less shallow joint cavities. The finding that among 7 babies no fewer than 4 had distensional luxation points in the same direction.

Children's plays vary with the seasons. In winter, for instance, skating, skiing and sliding are predominant. Starting from this we have investigated the frequency of distensional luxation in different ages and seasons. No obvious predominance of any particular age or season was found.

Case Reports

1. Coxitis simplex (journ. No. 1603/46). Girl aged 9. Trauma or infection not mentioned in anamnesis. No fever or rise of SR. No chemotherapy. Distensional luxation. (Fig. 2.)

2. Coxitis simplex (journ. No. 75/48). Boy aged 4. Trauma or infection not mentioned in anamnesis. No fever. SR 12 mm. Has not been able to rest on his right leg. No chemotherapy. Distensional luxation. (Fig. 3.)

3. Coxitis simplex (journ. No. 2843/47). Girl aged 7. No signs of infection. When sliding on ice on Dec. 18, the patient happened to get her legs widely apart, and she tumbled. Passing acute pain. Complained several times of pains, but showed no signs of difficulties in walking. On Dec. 22 worse. Began limping. SR and temperature normal. No chemotherapy. Distensional luxation.

4. Coxitis simplex (journ. No. 1740/47). Girl aged 5. Trauma or infection not mentioned in anamnesis. SR and temperature normal. Complained of pain in her right leg. No chemotherapy. Distensional luxation.

5. Coxitis septica (journ. No. 2094/45). Boy aged 2. Fell ill with rhinitis and pharyngeal infection. When pus from an abscess was examined, no bacteria were found either on immediate microscopical investigation or on culture. Sulpha preparation and penicillin were administered at an early stage. No osseous changes. Distensional luxation. (Fig. 4.) (Lauenstein's position.)

6. Osteomyelitis (journ. No. 1810/48). Boy aged 11. Had had slight pains in his right hip from time to time during the last few months before his admission. The symptoms had become acute when he happened to slip and fall on July 7. Pharynx moderately inflamed when the patient was admitted on July 10. Roentgen examination on July 11 negative. Roentgen examination on July 23 showed irregular attenuation at the edge of acetabulum. When re-examined in Dec. 1948 sclerosis was observed. Chemotherapy in large doses. Distensional luxation not observed on any occasion.

7. Osteomyelitis (journ. No. 2633/48). Girl aged 6. Sprained her left leg on Sept. 13. Began limping on Sept. 16. Had had a swollen throat. Had been given Acidum acetylsalicylicum. Temperature normal or slightly subfeverish. SR Sept. 22 24 mm.

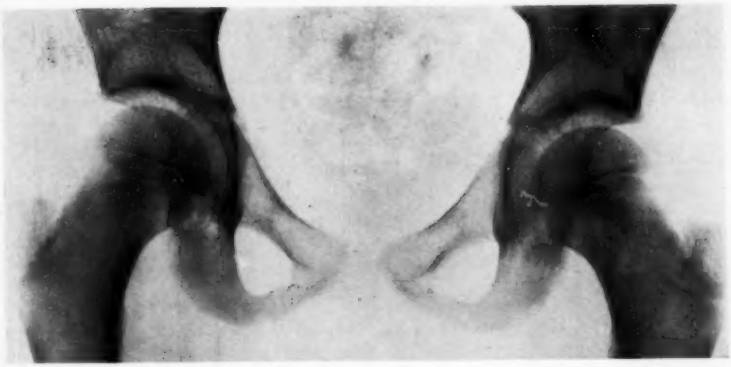

Fig. 2. Coxitis simplex dx. Girl aged 9. Distensional luxation.

Fig. 3. Coxitis simplex dx. Boy aged 4. Distensional luxation.

Fig. 4. Coxitis septica sin. Boy aged 2. Distensional luxation. No osseous changes.

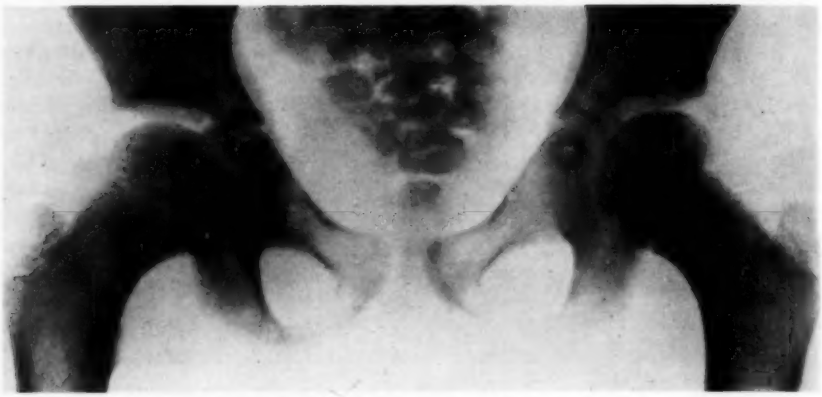

Fig. 5 a.

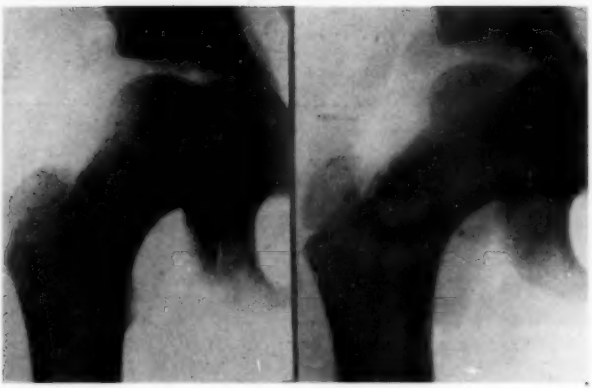

Fig. 5 b. Fig. 5 c.

Fig. 5. Osteomyelitis. Girl aged 6.

a. On Sept. 24 distensional luxation on the left side. A slight attenuation in collum femoris sin.
b. On Oct. 12 a large defect in the same place.
c. In Jan. 1949 healing with sclerosis.

When she was roentgen examined on Sept. 24, distensional luxation was observed and a slight attenuation in collum was faintly visible. Administration of chemotherapy was brought up for discussion, but on account of misunderstandings it was not carried out. When re-examined on Oct. 12, a large defect in collum femoris appeared. Large doses of penicillin and a sulpha preparation were administered. The osseous destruction has then gradually healed. When the patient was roentgen examined in Jan. 1949, only a slight sclerosis was observed. (Fig. 5 a—c.)

SUMMARY

The word distensional luxation used in the account indicates distension of the soft issues within the joint. In the differential diagnosis the occurrence of asymmetry and Morbus Perthes should be taken into consideration. In cases of hip pains the administration of chemotherapy must be seriously considered if distensional luxation is roentgenologically observed and SR and temperature are not manifestly normal. If there is no rise in SR and temperature, chemotherapy is of no great importance. Attention should then be paid to the following etiological moments: over-exertion, occasional greater trauma and infection of low virulence. The material of the Surgical Department of the Children's Hospital, Gothenburg, for the years 1945—1948 is discussed.

ZUSAMMENFASSUNG

Der Ausdruck »Dehnungsluxation» (distensional luxation) in diesem Bericht gibt eine Dehnung der Weichteile innerhalb des Gelenks an. Bei der Differentialdiagnose ist das Vorkommen von Asymmetrie und von Morbus Perthes zu berücksichtigen. Bei Fällen von Hüftschmerzen ist das Einleiten einer Chemotherapie ernstlich zu erwägen, wenn eine Dehnungsluxation röntgenologisch festgestellt ist und Blutsenkung und Temperatur nicht völlig normal sind. Wenn keine Erhöhung der Temperatur und der Blutsenkungswerte vorliegt, so ist Chemotherapie nicht von grösserer Bedeutung. Folgende ätiologische Faktoren sind zu berücksichtigen: Überanstrengung, einmaliges stärkeres Trauma und Infektion von geringer Virulenz. Das Material der Chirurgischen Klinik des Kinderkrankenhauses in Gotenburg aus den Jahren 1945—1948 wird besprochen.

RÉSUMÉ

L'expression de »luxation par distension», employée dans l'article, indique qu'il s'agit d'une distension des parties molles de la jointure. Pour le diagnostic différentiel il faut tenir compte de la possibilité d'une asymétrie ou d'une maladie de Perthes. En cas de douleurs de la hanche il faut sérieusement envisager l'administration de remèdes chimiothérapiques lorsqu'on constate une luxation par distension aux Rayons Roentgen et que la vitesse de sédimentation ainsi que la température ne sont pas manifestement normales. Si ni la vitesse de sédimentation ni la température ne présentent d'élévation, la chimiothérapie n'a pas grande importance. Il convient alors de porter son attention sur les facteurs étiologiques suivants: surmenage, traumatisme occasionnel plus considérable, infection de faible virulence. Le matériel de la Division Chirurgicale de l'Hôpital des Enfants à Gothenbourg, des années 1945—1948, fait l'objet de la discussion.

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PROCEEDINGS OF THE THIRTEENTH CONGRESS OF THE NORTHERN ASSOCIATION FOR MEDICAL RADIOLOGY

(NORDISK FÖRENING FÖR MEDICINSK RADIOLOGI) HELD IN COPENHAGEN, DENMARK, ON JUNE 14TH AND 15TH, 1946.

Edited by CARL SANDSTRÖM, *Secretary-General.*

LIST OF OFFICERS

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	Dr. B. EBENIUS,	Sweden.

The Congress was held on June 14th and 15th, 1946.
The Association voted unanimously to elect Professor LARS EDLING, Pjetteryd, Sweden, to honorary membership.
The Association voted to hold its next meeting in Helsingfors, Finland, in June, 1947.
The following officers were elected:

President:	Dr. GÖSTA JANSSON,	Helsingfors.
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	Dr. H. REITAN,	Norway
	Prof. E. BERVEN,	Sweden
	Prof. ÅKE ÅKERLUND,	Sweden.

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Auditors:	Dr. HUGO AHLBOM	
	Mr. CARL C. EDEMAR.	
Deputy Auditors:	Dr. GÖSTA RENCK	
	Mr. C. B. SCHMIDT.	

Professor ÅKE ÅKERLUND was elected to assist the President in correcting the minutes.

SECTION FOR DIAGNOSTICS.

Friday, June 14, 1946.

THOMAS ROSENDAL: The Significance of Roentgen Examination in the Operative Treatment of Scoliosis.

FOLKE KNUTSSON: Instability Conditions in the Lumbar Spine in Cases of Disc Degeneration. Nord. Medicin XXXI, p. 1879.

FOLKE KNUTSSON: The Use of Contrast in Myelography — Experiences of 350 Cases. Nord. Medicin XXXI, p. 1995.

OLLE OLSSON: The Technique of Lumbar Pneumomyelography. Acta Rad. 29: 107: 1948.

FLEMMING NØRGAARD: Arthrography of the Mandibular Joint.

ARNE ENGESET and ARNE TORKILDSEN: Changes in the Optic Canal in Cases of Intracranial Tumor. Acta Rad. 29: 57: 1948.

ARNE ENGESET: Changes in the Foramen Spinosum in Meningeoma Cases.

JOHAN TORGERSEN: Vertebra Plana in Lipoidosis. Acta Rad. 27: 638: 1946.

JOHAN TORGERSEN: Bronchiectasis and Nasal Polyps. Acta Rad. 28: 17: 1947.

TORLEIF DALE: Bone Necrosis in Divers.

BØRGE NIELSEN: Hysterosalpingographic Diagnosis of Extra-Uterine Pregnancy. Acta Rad. 28: 185: 1947.

JENS M. NORDENTOFT: Intussusception in Children.

FREDERIK MARSTRANDER: Demonstration of the Limits of Planigraphy in Pulmonary Disease.

GÖSTA RUNSTRÖM: Demonstration of a Film Examination Box with Switch Device. Acta Rad. 28: 859: 1947.

Saturday, June 15, 1946.

TORFINN DENSTAD: Hyperostosis Cranii. Acta Rad. 28: 129: 1947.

I. POIJÄRVI: On the Differences of Opinion between Roentgenologists and Surgeons in Cases of Duodenal and Stomach Ulcers. Nord. Medicin XXXV, p. 1607, 1947.

P. FLEMMING MØLLER and FLEMMING NØRGAARD: Routine Examination of the Small Intestine and the Normal Small Intestine Pictures.

P. FLEMMING MØLLER, P. PLUM and FLEMMING NØRGAARD: The picture of the Small Intestine in Infantile Sprue.

P. FLEMMING MØLLER: Further Discussion of the Above.

J. FRIMANN-DAHL: Venography of the Lower Extremities. Acta Rad. 28: 199: 1947.

O. W. HUSEBY: The Roentgen Diagnosis of Acute Jejunitis. Acta Rad. 29: 71: 1948.

FOLKE KNUTSSON: Cases of Discus Articularis of the Knee Joint.

GÖSTA JANSSON: A Contribution to the Roentgen Diagnosis of Tumor of the Adrena Glands.

KNUT LINDBLOM: Experiences in the Diagnostic Puncture of the Kidney. Acta Rad. 27: 66: 1946.

OLLE OLSSON: Renal Colic in Cases of Tumor and Tuberculosis of the Kidneys. J. Urol. 60, 1948.

OLLE OLSSON: Cystography with Graduated Compression. Acta Rad. 29: 429: 1948.

HARRY HOLM: Pyelogenous Kidney Cysts Demonstration. Acta Rad. 29: 87: 1948.

P. FLEMMING MOLLER and P. ESKILDSEN: Incipient Stages of Porcelain Silicosis. Acta Rad. 27: 601: 1946.

CARL WEGELIUS Pulmonary Asbestosis and Its Occurrence in Finland. Acta Rad. 28: 139: 1947.

SECTION FOR THERAPY.

Friday, June 14, 1946.

VIGGO E. THAYSSEN: The Influence of Castration by Roentgen on Cancer of the Breast. Acta Rad. 29: 189: 1948.

JORGEN E. THYGESEN: Roentgen Biology as a Step in Functional Pathology. The General Reactions of the Cells and the Organism to Traumatic Agents (Outline of a working Hypothesis). Acta Rad. 28: 1: 1947.

JAMES HEYMAN: Experiences in the Radiological Treatment of Cancer in the Corpus Uteri. Acta Rad. 27: 328: 1946.

ROLF BULL ENGELSTAD: Treatment of Carcinoma Penis at the Norwegian Radium Hospital.

SVEN LOMHOLT: Bucky Treatment and Its Secondary Effects. Proceedings of Northern Dermatological Soc. 11. Meeting 1948, p. 234.

ERIK EBBEHOJ: Ultra-Soft Roentgen Rays and Possible Ways of Using them in Surface Therapy.

S. MUSTAKALLIO: Result of Roentgen Therapy in Histologically Verified Cases of Pulmonary Cancer. Annales Med. internae Fenniae 35: 108: 1946.

STIG KULLANDER: Some Points of View on Roentgen Sickness and its Treatment. Acta Rad. 28: 221: 1947.

Saturday, June 15, 1946.

CARL KREBS: The Significance of Supplementary Roentgen Treatment in the Cure of Cancer of the Uterus.

AXEL SAUGMAN: Biological Control of the Reflector Effect in Ultra Violet Waves.

SIGVARD KAAE: Pre-operative Roentgen Treatment in Breast Cancer. Acta Rad. 28: 153: 1947.

HOWARD NIELSEN: Dosage Problems in Rotation Roentgen Treatment.

FRIDTJOF TRUELSEN: Results of Treatment of Cancer of the Neck of the Uterus at the Radium Station in Copenhagen.

JOHS. CLEMMESEN: The Cancer Register of the National Anti-Cancer League, Copenhagen.

PROCEEDINGS OF THE FOURTEENTH CONGRESS OF THE NORTHERN ASSOCIATION FOR MEDICAL RADIOLOGY

(NORDISK FÖRENING FÖR MEDICISK RADIOLOGI) HELD IN HELSINGFORS, FINLAND, ON JUNE 11TH AND 12TH, 1947.

Edited by CARL SANDSTRÖM, *Secretary-General.*

LIST OF OFFICERS.

President:	Dr. GÖSTA JANSSON,	Helsingfors, Finland.
Honorary Presidents:	Prof. CARL KREBS,	Denmark
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	Dr. S. MUSTAKALLIO,	Finland
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	Dr. B. FABER,	Denmark
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	Dr. PETER NATVIG,	Norway
	Dr. K. LINDBLOM,	Sweden.

The Congress was held on June 11th and 12th, 1947.
The Association voted to hold its next meeting in Oslo, June, 1948.

The following officers were elected:

President:	Prof. T. DALE,	Norway.
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	Mr. C. O. EDEMAR.	

Deputy Auditors: Dr. S. R. KJELLBERG
Mr. C. B. SCHMIDT.

Prof. ÅKE ÅKERLUND was elected to assist the President in correcting the minutes.

SCIENTIFIC TRANSACTIONS.

Wednesday, June 11, 1947.

SÖLVE WELIN: The Roentgenological Diagnosis of Bone Tumors (Survey lecture by invitation).

J. FRIMANN-DAHL: The Roentgen Examination in cases of Acute Dilatation of the Stomach (Survey lecture by invitation). Acta Rad. 29: 237: 1948.

BJÖRN LINDHOLMER: The Functioning of the Stomach after Vagotomy.

C. SANDSTRÖM: Some Observations Concerning the Tonus of the Stomach Wall.

E. TAMMIA: Are the Large Ulcers in the Corpus Ulcerating Carcinomas?

HANS G. SKARBY: Roentgen Findings in Appendicitis and Abscesses of the Appendix.

HELGE ELTORM: Inflammatory Conditions of the Colon.

ROLF KÖHLER: Primary Malignant Tumors in the Small Intestine, with special reference to their Roentgen Diagnosis.

KAI MALMIO: On Roentgen Diagnosis in cases of Traumatic Diaphragmatic Hernia.

SEVED RIBBING: Layer Formation in Urinary Tract Examination. Nord. Medicin XXXX, p. 2038.

SVEN R. KJELLBERG: Congenital Stricture of the Urethra.

C. E. NYLUND: Coxa valga subluxans.

YRJÖ PAATERO: The Use of a Movable Source of Light in Radiography. Acta Rad. 29: 221: 1948.

NILS CHRISTIANSEN: The Different Forms of Phthisiogenous Infiltrations and the Development of Phthisis. Acta Rad. 30: 17: 1948.

CARL ERIK JOHANSSON: Our Experience of Abrodil Myelography.

Thursday, June 12, 1947.

CARL KREBS: Cancer and Chemotherapy.

SAKARI MUSTAKALLIO: The treatment of Cancer of the Breast, with particular reference to Simple Extirpation of Tumors and Roentgen Therapy.

HANS LUDVIG KOTTMEIER: Some Observations concerning Roentgen Treatment of Pre-Climacteric Uterine Bleeding, based on a clinical and experimental examination at the Radiumhemmet, Stockholm. Acta Rad. 28: 736: 1947.

S. N. BAKKE: High Voltage Equipment at the Haukeland Hospital and High Voltage Treatment.

CARL WEGELIUS: Biological Effects of Capacitive Electric Loading and the Magnetic Fields in Roentgen Treatment. Acta Rad. 28: 468: 1947.

KAI SETÄLÄ: Preliminary Observations on the Effects of Irradiation upon the Chylomicrons in Human Blood. Radiology (U. S. A.) Vol. 50, p. 803—810, 1948.

HARRY MOSSBERG: Thrombocytopenia in Local Roentgen Treatment. Acta Rad. suppl. LXVII, 1947.

ARNE FRANTZELL: Roentgenological Changes in Three Cases of Penicillin-Treated Osteomyelitis in Children.

GÖSTA RUNSTRÖM: Preliminary Report on Abdominal Aortography. Nord. Medicin 39, p. 934, 1948.

I. G. Porjé: The Arterial Pulse Wave. Roentgenokymography. Acta Rad. 29: 509: 948.

F. Ulfsparre: Special Diagnostic Procedures in Cases of Congenital Cyanosis.

Oliver Axén: Angiography in Children. Revista Española de Pediatría vol. IV r 2, p. 161, 1948.

Ernst F. Salén: On Angiocardiography and its value in Intrathoracic Incision.

Bengt Holmgren: The Origin of the Zenker Diverticula. Acta Rad. suppl. LXI, 1946.

Kurt Wahlfors: Pneumoarthrography.

PROCEEDINGS OF THE FIFTEENTH CONGRESS OF THE NORTHERN ASSOCIATION FOR MEDICAL RADIOLOGY

(NORDISK FÖRENING FÖR MEDICINSK RADIOLOGI) HELD IN OSLO, NORWAY, ON JUNE 11TH AND 12TH, 1948.

Edited by CARL SANDSTRÖM, *Secretary-General.*

LIST OF OFFICERS

President:	Prof. T. DALE,	Oslo, Norway.
Honorary Presidents:	Prof. P. FLEMMING MØLLER,	Denmark
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	Dr. S. MUSTAKALLIO,	Finland
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	Dr. R. BULL-ENGELSTAD,	Norway
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Secretaries of the Congress:	Dr. TH. ROSENDAL,	Denmark
	Dr. CARL-ERIK JOHANSSON,	Finland
	Dr. ERIK POPPE,	Norway
	Dr. SÖLVE WELIN,	Sweden.

The Congress was held on June 11th and 12th, 1948.
The Association voted to hold its next meeting in Stockholm, in June, 1949.

The following officers were elected:

President:	Prof. E. BERVEN,	Sweden.
Members of the Board:	Prof. P. FLEMMING MØLLER,	Denmark
	Prof. C. Krebs,	Denmark
	Dr. S. MUSTAKALLIO,	Finland
	Dr. CARL WEGELIUS,	Finland
	Prof. T. DALE,	Norway
	Dr. R. BULL-ENGELSTAD,	Norway
	Prof. ÅKE ÅKERLUND,	Sweden
	Dr. K. LINDBLOM,	Sweden
	Dr. G. JÖNSSON,	Sweden
	Dr. SÖLVE WELIN,	Sweden.
Deputy Members of the Board:	Dr. CHR. J. BAASTRUP,	Denmark
	Dr. Y. LASSILA,	Finland
	Dr. J. FRIMANN-DAHL,	Norway
	Dr. E. LINDGREN,	Sweden.

Treasurer:	Dr. FOLKE KNUTSSON	Sweden.
Secretary-General:	Dr. CARL SANDSTRÖM	Sweden.
Auditors:	Dr. H. AHLBOM Mr. CARL EDEMAR	
Deputy Auditors:	Dr. R. KJELLBERG Mr. C. B. SCHMIDT	

Prof. ÅKE ÅKERLUND was elected to assist the President in correcting the minutes.

SCIENTIFIC TRANSACTIONS.

Friday, June 11, 1948.

H. G. SKARBY: Some Cases of Limy Bile.

G. RUNSTRÖM: Is there any Connection between the Infantile Pyloric Stenosis and the Benign Pyloric Stenosis in Adults?

E. DE FINE LICHT: The Roentgen Diagnosis of Hyperthrophy of the Pylorus in Adults.

K. ANDERSEN: An operated Case of Hypertrophy of the Pylorus in a Man 39 years old.

J. FRIMANN-DAHL: Direct Demonstration of Perforated Ulcer Crater on plain films. Acta Rad. 30: 177: 1948.

P. AHLBERG, Å. GIDLUND, H. LÖNROTH and CARL SANDSTRÖM: The Diagnosis of Acute Abdominal Conditions, especially Ileus.

Y. SEUDERLING: A Case of Gastro-Duodenal Fistula.

L. WALLDÉN: Roentgen diagnosis of Dyschezia in Cases of deep Douglas' Pouch.

C. E. JOHANSSON: Cystourethrographic Investigation with special combination of Contrast media.

N. P. G. EDLING: The Roentgen findings in a Carcinoma of the Prostate.

S. RIBBING: An Apparently Unknown Disturbance of the Skeleton. (Will be published in Acta Rad. 31: 1949.)

T. DALE: Osteochondrodystrophy.

E. C. ASTRUP: Osteochondrodystrophy.

A. SCHEEL: Roentgenological Studies of the Bone Structure in Different Pathological Conditions.

S. WELIN: A Roentgen-Microspectrographic Investigation of the Inflammatory Destruction of the Mastoid Bone. Brit. Journ. Radiol. 1949.

K. LINDBLOM: Diagnostic Puncture of the Intervertebral Disc.

F. KNUTSSON: Observations on the Growth of the Vertebral Body in cases of Scheuermann's Disease.

F. KNUTSSON: The Axial Projection of the Shoulder Joint. Acta Rad. 30: 214: 1948.

Å. GIDLUND: Demonstration of a Cannula for Arthrography of the Shoulder Joint.

W. EDGREN: A Method for Determination of the Anteversion in Cases of Congenital Dislocation of the Hipjoint.

T. ROSENDAL: Coxa Valga and Increased Antetorsion after Acute Anterior Poliomyelitis.

OLLE OLSSON: A New Technique for the Roentgen Examination of the Kidney and of the Uterus during Operation.

ARNE FRANTZELL and B. E. ENGELMARK: The Muscle Fat, Its Arrangement and Amount at Different Ages — a Roentgenological and Morphological Study.

J. SLØRDAHL: Some Cases of Osteopoikili.

P. M. KJELLAND: Osteopoikili.

F. MARSTRANDER: A Roentgenological Table Top.

E. POPPE: How should Osteogenic Sarcoma be treated? (Will be published in Acta Rad. 31: 1949.)

P. A. BLINKENBERG: The Results of Roentgen Treatment of Hyperthyroidism.

E. EBBEHØJ: The Treatment of Skin Cancer.

E. MOSEKILDE: The Results of Therapy in Carcinoma of the Skin with Ultrasoft Roentgen Rays.

I. GYNNING: Rotation Therapy of Cancer of the Esophagus.

E. POPPE: Injuries Produced by Contact Roentgentherapy. Acta Rad. 30: 365: 1948.

A. ENGESET: The Roentgen treatment of Glioma of the Brain.

H. AHLBOM: Roentgentherapy of Polymyositis.

T. DALE: An Operated and Roentgen treated case of Lymphogranulomatosis followed for 20 years.

R. BULL-ENGELSTAD: Therapy for Cancer of the Breast.

E. SCHJØTT-RIVERS: The Results of the Treatment of Cancer of the Cervix uteri at the Norwegian Radium Hospital.

S. HULTBERG: Experiences in Nitrogen Mustard Therapy.

K. SETÄLÄ: Roentgen Sickness.

Saturday, June 12, 1948.

L. NITTER: Changes in the Lungs in Cases of Boeck's Disease.

P. E. HEIKEL: A Self-acting Exposure for Roentgen Examination of the Lungs in Infants.

M. KOLSRUD: Body Section Radiography.

F. MARSTRANDER: Planigraphy — Comparison Investigations.

H. F. FABRITIUS and H. ODEGAARD: Bronchitis with Bronchostenosis. Acta Rad. 30: 385: 1948.

S. WELIN: Some Observations on the Roentgen Diagnosis of Non-Opaque Foreign Bodies Aspirated into the Bronchi. Acta Rad. 29: 529: 1948.

F. MARSTRANDER: An Apparatus for Broncho-Catheterization.

C. WEGELIUS: Fluorography. Its Results from a Roentgenological View Point.

R. WEYDE: Mediastinal Phlebography in Cases of Bronchiogenic Carcinoma.

Å. GIDLUND: The Roentgen Diagnosis of the Mitral Disease.

O. W. HUSEBYE: Calcification of Ductus arteriosus Botalli.

OLLE OLSSON: The Tolerance of Cerebral Blood-vessels to a Contrast Medium of the Diodrast Group. Acta Rad. 30: 326: 1948.

T. FRANCIS: A Method for Foreign Body Localization.

S. RADNER: Angiographic Examination of the Vertebral Artery by Catheterization from the Radial Artery. Acta Rad. 29: 178: 1948.

O. W. HUSEBY: The Venographic Technique.

J. SLORDAHL: Aortographic Examinations at Ullevål Hospital, Oslo.

H. HOLM: A Case of Cerebellar-Abscess Diagnosed by Angiography of the Vertebral Artery.

Errata

In the paper »Roentgen Examination of the Subtaloid Joint in Fractures of the Calcaneus» by BROR BRODÉN in Vol. XXXI, fasc. 1, pages 85—91, the numerals under Figs. 12, 13 and 14 on page 88 should be *40°*, *30°* and *10°* respectively (instead of 400, 300 and 100) and the numerals under Figs. 16, 17 and 18 on page 89 *40°*, *30°* and *20°* respectively (instead of 400, 300 and 200).